THE TELEGRAPHIC JOURNAL AND

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THE EVOLUTION OF ELECTRICAL SCIENCE.

THE great theory of evolution which, in so far as it relates to biological science, has been so splendidly emphasised by Darwin and Wallace, and has been so well supported by other scientists of the new school, has quickened the thought of the whole of the civilised world, and borne fruit in every direction When future historians, years hence, shall write the history of these times, we doubt not that they will class this great intellectual movement beyond even the Revival of Learning in the Middle Ages.

The *scientific method* is now applied to every department of knowledge; we observe, hypothecate and then verify, and the result is that discovery follows discovery with extraordinary rapidity, compared with which the progress obtained by earlier philosophical systems, when there was any, stands out in strong and unfavourable contrast.

The evolution hypothesis receives splendid support and systemisation from the synthetic philosophy of Herbert Spencer. The "sensation" philosophy of Locke and Hume, and the *à priori* speculations of Kant, have been by Spencer's insight found to be different halves of the whole truth that knowledge is derived from experience, but the experience of the race furnishes innate ideas to the individual. Whatever chiselling time may effect in the body of this doctrine, we believe that the leading principles will remain intact.

Evolution may be traced in every art and science; we can understand now the special unfolding of each branch, and by studying the phases through which any art or science has passed in the course of being evolved, we may not only appreciate better the true bearing of the knowledge acquired, but may learn to see more clearly how our knowledge is to be advanced.

It was an excellent idea that prompted the Brooklyn Ethical Association, U.S.A., to institute a series of lectures and discussions upon evolution in science and art a short time ago. These lectures have now been published, and they show not only how each branch of knowledge has been evolved, but also sketch the outlines of the methods employed by the leading evolutionists.

One of these lectures is of special interest to the readers of the ELECTRICAL REVIEW, for it deals with "The Evolution of Electric and Magnetic Physics." The subject is treated by Mr. Kennelly, who skilfully traces the growth of our knowledge from the vague theories of the ancients to the definite complex science of to-day, and he shows that the development of electrical science is closely illustrative of the evolutionary law.

The growth of electrical knowledge is a matter of comparatively recent history; for twenty-two hundred years it lay, as it were, dormant. The seventeenth century witnessed investigations of electrical phenomena, and of the properties

of magnets; but then for about two centuries it was hardly suspected, and certainly never realised, that any connection existed between them. It was, in fact, only after Oersted's discovery in 1820—that a magnetic needle is deflected by the electric current—that electro-magnetism became a *science*. Its subsequent progress, however, was correspondingly rapid, and its offspring are the crowning inventions of to-day.

Thales suggested electricity as a condition of life, and Mr. Kennelly is apparently inclined to agree with him. "It is possible," he says, "if it is not at present demonstrated, that electricity may be the active principle in the processes of animal vitality; . . . . and that the relation between electricity and vitality may be so close as to amount to identity." This is, perhaps, pardonable in the chief electrician of Edison's laboratory; but it is very doubtful if any eminent physiologist, or psychologist, will allow that nerve-fibres do more than artificially resemble insulated wires, or that a dynamo can confer any degree of immortality. We are probably far from being able to answer specifically the pertinent question, "What *is* electricity?"

THE FERRANTI HIGH TENSION SCHEME.

OUR contemporary, the *Engineer*, which has hitherto been one of the warmest advocates of the high tension system of electric lighting as set forth by that clever enthusiast, Mr. Ferranti, has now practically abandoned its views of the situation, if we can judge from a recent utterance. The following short article, which we print in full, appeared in the last number of that journal, and it practically admits that the view we have all along taken of the position of affairs is substantially correct.

"Certain alarmist reports, *not more unfounded than unfair*, have been circulated concerning the London Electric Supply Corporation. These reports have, as a matter of course, been put into circulation by those who *have taken no trouble to verify their truth*. It has been stated that there have been very serious breakdowns which could have been entirely avoided had Mr. Ferranti remained engineer to the firm. *The truth is that certain failures of insulation have occurred* —in one case owing to the bursting of a water main in a street—but *principally due to the tremendous pressure*, 10,000 *volts*, which has been recently put on the mains and transformers. The only result of the partial failures in question has been that one or two circuits were left without light for a few hours during three evenings. Mr. Dalton, the engineer to the Corporation, Dr. Fleming, its consulting electrician, and the staff are quite competent to deal with these difficulties, and all the four great dynamos and their engines and the mains are now in perfect running order. *The question suggests itself, however, whether, after all, it is any way advisable or necessary to work at* 10,000 *volts. The troubles incurred at that tremendous pressure can hardly be realised by those who have had no experience—and very little experience is possessed by anyone—of them.* If the mains were limited in section, there would, of course, be a reason; but they are quite competent to supply 60,000 or 80,000 lights, with a pressure of 2,500 volts, and when the development of the demand throws more work on the cables, then let converters be employed in the magnificent premises at Deptford, where there is ample room to raise the potential, the dynamos still generating at 2,500 to 3,500 volts. *It seems to us that if the Corporation would adopt this plan, the splendid situation, fine plant, facilities for getting coal, possessed by the Corporation, would place and keep it in the first rank among electrical companies.*"

It will be observed that although at the commencement of the article the reports are stated to be *unfounded and unfair* (the italics are our own), yet the italicised paragraph commencing "The question suggests . . . ." practically admits that the system is a mistake, and must be abandoned for something more reasonable.

We quite agree that the Corporation is in many respects in a good position to do excellent work; but this can only be fully taken advantage of by materially modifying the existing state of things. Probably this must involve a heavy outlay, but such an expenditure can hardly be called throwing good money after bad; for although it will for some time to come render the payment of good dividends almost impossible, yet it may at least prevent what has already been spent being practically lost.

UNDERGROUND ELECTRIC LIGHT MAINS.

A PAPER on this subject, prepared by Mr. J. O. Callender, was read last month before the Engineering Association of New South Wales, in which the author described most of the systems now in use by supply companies, and discussed the question of what would be the most suitable system to adopt for the underground mains of the City of Sydney, where circuits will be required for arc and incandescent lighting, for the telegraph and telephone service, and for fire alarm and other municipal wants.

The author divides underground mains into three classes, viz.:—1. Solid systems, such as the Edison, Ferranti, and Callender systems, and those employing lead-covered cables; 2. Drawing-in systems using iron pipe conduits, Callender-Webber conduits, earthenware conduits and wooden conduits; and 3. Bare copper systems, such as the Crompton, Kennedy, and St. James's systems; a description being given of each of the systems referred to, and their respective merits discussed. In this part of the paper two claims are made for the Callender-Webber system, which we think would have been challenged by some of our English engineers, viz., that the Callender-Webber drawing-in system was the first complete system of this class to be introduced in England, and that bitite cable can be easily and perfectly jointed, and in this particular has great advantages over vulcanised rubber. As regards the former, the cast-iron pipe drawing-in system, which has been used for so many years by the Post Office, may certainly claim priority, and even if this be excluded as not being employed by them for lighting mains, we believe that several examples of drawing-in systems complete with conduits and manholes could be named, which were in existence prior to the introduction of the Callender-Webber system; and as regards the latter statement, we have always understood that manufacturers and users of rubber cable laid considerable stress on the advantages afforded by that material for the making of reliable joints.

Coming, now, to the second part of the paper, we find that the author arrives at the conclusion that a drawing-in system should certainly be employed, and he then proceeds to show how the Callender-Webber system would adapt itself to the requirements of the service in Sydney. Mr. Callender proposes that a group of four casings, each with four or more ways through it, should be laid under the footway, arranged two side by side and two deep, and that they should be apportioned to the various services in the following manner: One of the lower casings would be used for telegraph and telephone wires, and the other for high tension alternating current feeders for private lighting: whilst above the former would be placed the arc light mains, and above the latter the low tension distributing mains for private lighting. So far as we can see, equal advantages would be afforded by any other drawing-in system, but it appears to us that whatever conduit is used, the difficulties arising from the close proximity of arc light and alternating currents to the telegraph and telephone wires would be very considerable, unless those responsible for the working of the latter services in Sydney are inclined to deal more kindly with the lighting companies than our own Post Office seems to be. Of course, if a complete system of metallic return with twisted or concentric cables was used for the telegraph and telephone service, such a scheme as that proposed might be worked satisfactorily; but so long as the onus of not interfering in any way with the working of telegraph lines is thrown entirely on the lighting companies, as is the case in London, there is very little chance of any such comprehensive scheme being brought forward.

A NEW USE FOR THE INCANDESCENT LAMP IN PHOTOGRAPHIC STUDIOS, &c.

THOSE who, from an amateur or professional standpoint, have had anything to do with photography, are well aware of the importance of stability in their various installations; vibratory motions of the supports, &c., are fatal to good results, and hence a small vessel of mercury is commonly used in order to indicate whether the apparatus is steady.

A much more delicate test of stability is an incandescent electric lamp. The mobility of the filament is extreme; it responds to the least vibration; and this is especially the case if the continuity of the filament be interrupted. A lamp that would otherwise be thrown aside as useless for illuminating purposes may thus be made to serve a useful purpose.

It will easily be understood that the length of the filament is a condition of its sensitiveness to vibration, hence the Swan lamps are to be recommended for this particular use. But it must not be supposed that a lamp with an imperfect "vacuum" will do, for when air has leaked into the bulb it opposes a resistance to the vibrations of the filament, and hence it becomes not nearly so sensitive. Neither is a lamp that has been blackened by the "bombardment" of the carbon particles at all suitable, because then the delicate movements of the filament are perceived with difficulty.

To use the incandescent lamp for the purpose described is by no means the only use, of this order, to which it can be applied. We all know from sad experience the annoyance of vibratory movement in our testing rooms, and in order to get rid of it great expense must often be incurred, and separate foundations must be given to each floor, as in the Cavendish Laboratory at Cambridge. And it is very difficult to determine whether there is much vibration until the instruments have been properly installed.

But now the incandescent lamp test can be applied. It was used recently by Mons. F. Leconte at the Institut des Sciences de Gand. He required to verify the stability of the stone supports which rest upon the foundations in the Laboratory of Physics there. Upon one of these supports he placed a telescope, and upon the other a Khotinsky lamp, and he made such dispositions and arrangements that the vibrations of the filament could readily be observed through the telescope. He waited about ten minutes until there was complete repose, and then gave several sharp taps upon the floor of the laboratory, noting the number of seconds taken by the filament in again coming to the state of rest. The usual mercury tests were entirely incompetent to show vibrations which the incandescent lamp readily responded to. With a little care this test of stability might be made of a quantitative nature, and thus its usefulness would be greatly enhanced.

Should our readers be further interested in this experiment, they will find a paper by Mons. Leconte in one of the recent issues of the *Bulletin de l'Association Belge de Photographie.*

EFFECT OF INCANDESCENT LAMPS ON THE EYESIGHT.

As civilisation advances, and science places within the reach of the community luxuries and conveniences which a former generation scarcely dreamt of, much less possessed, it is not surprising to hear that new diseases arise. No doubt the style of living adopted by the present inhabitants of the earth has exterminated many of the diseases which caused great mortality amongst our forefathers. Sanitary science, and a greater regard for personal cleanliness—this in no way disparaging to our ancestors—have certainly combined to make us pleasanter creatures than, to say the least, we might have been. Although many ills have been banished, other diseases owe their birth to our refined mode of living. That a great many of these are fancied there can be little doubt, and they are often cured by the same imaginative means. The correspondence in the columns of the *Morning Post* on the subject of electric lighting would appear to owe its existence to a mind anxious about the hurtful tendencies of an incandescent lamp. Whether the correspondent who set the ball rolling, stared at a naked lamp until he felt certain painful effects, is not stated; but another correspondent said that, whether shaded or not, the light from an incandescent lamp caused him great distress. It may be reasonably admitted that to allow the unshaded filament to shine directly on the eye, must have bad results; the same would be true, though perhaps in a lesser degree, of any other form of artificial light. It is thought by a high authority in these matters that it hurts the eye more to look direct at a 16 C.P. incandescent lamp than to look at a gas flame of similar power.

With the gas flame the luminous image on the retina covers more surface than it does with the incandescent filament, and consequently the intensity of light on the points covered is greater with the electric light. Recognising the fact, however, that the electric light has now been used in London for a considerable period, it would appear that those who use it have taken due precautions with their lamps, for the cases of injury to the eye are most rare. At the General Post Office, where it is to be presumed the *employés* have no time to stare at the lights, there have been no complaints whatever of the evil effects of the electric lamp, and men of the greatest experience in electric lighting declare that they have no knowledge of evil results arising when properly shaded lamps are used. The main question raised in the *Morning Post* seems to resolve itself into one of properly shaded lamps. We grant that the incandescent lamp, even shaded, might cause to a sensitive or weak eyesight extreme pain, but cases such as these would be equally affected by all strong lights, and they only count as isolated instances. But, broadly speaking, an incandescent lamp properly shaded ought not to influence in any way a fairly healthy eyesight. We do not say that all lamps are properly protected, for there is in too many places a desire to sacrifice good light for mere intensity. It will, perhaps, not be too much to hope that people will learn better in this respect, and become convinced that the best lighting effects are obtained when the rays from the lamps are systematically diffused.

A Chance still left for the Gas Companies.

THE development of gas-motors during the past thirty years is significantly illustrated by the fact that at the last Paris exhibition nearly sixty different models were exhibited, whereas at the exhibition in 1863 only three were shown. They now return in the form of mechanical energy a large percentage of the heat energy put into them, which is a result of improved design and construction. This was commented upon by Mons. Moreau at a recent meeting of the Société des Ingenieurs Civils, in a paper in which he compared the gas engine with the steam engine, greatly to the disadvantage of the latter. It appears that the gas engine is very superior as regards its thermic output. Mons. Moreau stated, in fact, that theoretically this kind of motor is capable of double the return of the average steam engine. But the special point of interest elicited by Mons. Moreau was the observation attributed to Witz, namely, that it is preferable from an economic point of view to use a gas engine to drive a dynamo in obtaining electric light, rather than to turn the gas direct for purposes of illumination. The thermic return of gas is vastly superior to its illuminating return, and Mons. Moreau emphasised the truth that apart from sanitary considerations we should achieve greater economy by using gas, not as a source of direct light, but as a source of power in driving our dynamo machinery, thus getting our light indirectly; this truth, however, has long been understood in electrical circles. Therefore the gas companies may take courage; they are not yet threatened with total extinction, and in the future—the immediate future, perhaps—may still find employment for their gas as the *handmaid* of electricity.

Coast Communication.

MR. J. LAWRENCE-HAMILTON, late honorary president of the Fishermen's Federation, has compiled the following interesting information and suggestions relative to the all important subject of telegraphic coast communication:—Including 58 signal stations, the United Kingdom has 680 coast guard stations and detachments, which, in case of war, will be increased by 78 extra stations within a mile of a telegraph office. At present these 680 coastal stations are locally "near" to telegraph stations, open only from 8 a.m. to 8 p.m., and generally closed all Sunday. It appears that no information has hitherto been collected or published as to the distance of these coastal stations from local telegraph offices, open all day and all night, including Sundays. For defensive purposes during war, and to save life and property at sea, including stranded vessels, both during peace and war, each of these coastal stations should have its coast guards, now numbering 4,200 men, taught and trained to work telegraph instruments, kept at each coastal station, open day and night without any intermission. These coastal stations should form a complete continuous telegraphic circuit round our coasts and islands, also communicating with life boat stations, and with inland telegraph stations, so as to keep the authorities and Lloyd's informed. For 1891-92 the surplus postal profits have been estimated at £3,371,000, part of which might supply the present deficient telegraphic British coastal communication. The following table shows that these 680 coastal stations are at varying distances, some upwards of 35 miles from the "nearest" local telegraph office, which offices are mostly open only from 8 a.m. to 8 p.m., and closed usually all Sunday;—Under ½ mile, 228 coastal stations; 1 mile, 228; 2 miles, 54; 3 miles, 76; 4 miles, 60; 5 miles, 58; 6 miles, 39; 7 miles, 24; 10 miles, 25; 15 miles, 29; 20 miles, 5; 25 miles, 1; 30 miles, 0; 35 miles, 3; 40 miles, 1; total, 680 coast guard stations and detachments.

Granulated Iron Cores.

FROM an article under this heading, we quote our American contemporary, *Electricity*:—"The prevention of Foucault currents," says the London *Electrical Engineer*, "is one of the great objects of the constructing electrical engineer, and if a better method than the use of simple laminated cores could be made practicable, it is possible that the loss in that direction might be further reduced. Whether this can be done in the way advocated by Mr. S. C. Currie is for practical dynamo builders to say. The idea has probably presented itself, but we do not remember any case in which it has been actually employed. This method is to build up the cores and armatures from iron in a granulated form, such as iron filings, first oxidised or coated to prevent magnetic contact, and then compressed into a solid mass." *Electricity* printed the above clipping to show how *not* to do it. Foucault currents would undoubtedly be prevented by the method advocated by Mr. S. C. Currie, but the magnetic circuit would be most effectively destroyed. Our American contemporary wonders that any person with practical knowledge of magnetism should suggest such a plan, or that it should be given currency by a reputable electrical journal such as its esteemed contemporary the *Electrical Engineer* certainly is. *Electricity* is right. Profs. Ayrton and Perry constructed a dynamo with an armature core consisting of iron filings in a hollow brass ring. It did not work.

Engine and Dynamo Efficiency.

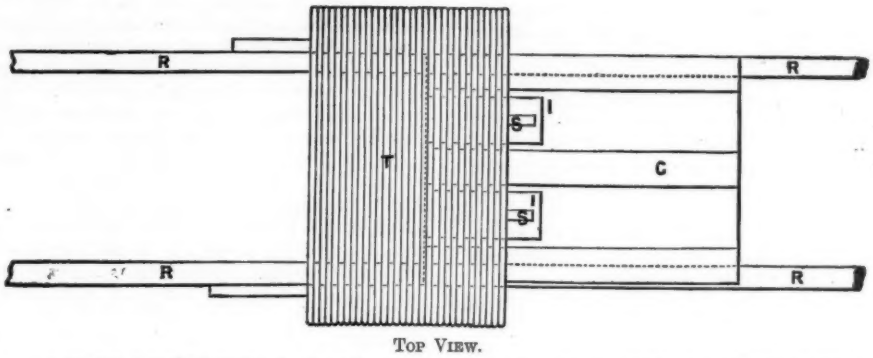
MR. CROMPTON'S letter suggests a very important question. Can he, or anyone else, point to a single instance where a return of 87 per cent. of the indicated engine power has been measured at the dynamo terminals? We do not speak of trial runs, but of actual work in central stations, and we challenge Mr. Crompton to give a formal guarantee to central station managers, that any combined engine and dynamo plant may be looked upon with certainty to produce such high results. The vagaries of steam engine indicators are well known, and if those employed by Messrs. Willans and Robinson are correct others must be wrong; but even the Thames Ditton firm admit a loss of 10 per cent. for friction in their engines, and suggest that it is not unwise to increase it to 15. If this allowance is made for friction the dynamo must give more than 100 per cent. efficiency to reach Mr. Crompton's figures. We should much like to hear what the consensus of opinion would be on the combined efficiency of engine and dynamo such as are now being employed in central stations.

THE FORERUNNERS OF THE ELECTRICAL TRANSPORTATION SYSTEM OF THE NEW ENGLAND PORT-ELECTRIC COMPANY.

BY A. M. TANNER.

THE ELECTRICAL REVIEW of October 31st, 1890, and the *Electrical World* of May 4th, 1889, contains illustrations and a description of an electrical transportation system, making use of stationary solenoids, through which an iron carrier is drawn by successively passing an electric current through the solenoids. It appears that the general construction and the principle involved in this electrical transportation system was suggested many years ago by the Chevalier Bonelli and Prof. Minotto, both of Turin, Italy.

An English patent obtained by Bonelli on the 8th day of January, 1862, No. 58, is for an "apparatus for transmitting despatches and small articles by the agency of electricity." In the specification of this patent it is stated that the "essential feature of novelty is the adaptation of the tractive power of induced electric coils to cause an armature of iron constructed in the form of a hollow vessel or casing made to contain articles of various kinds to pass along or through lengths of tube surrounded by such electric coils." The following figure taken from the drawing of the English

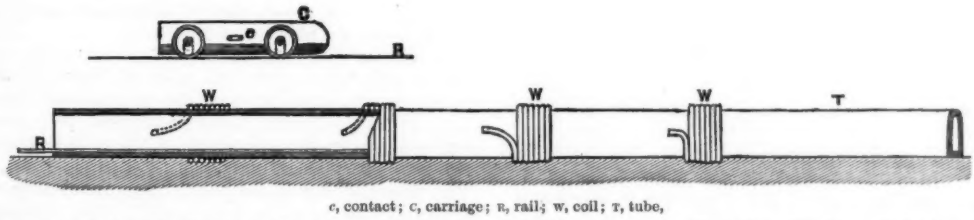


TOP VIEW.

C, carriage; I, insulated metal plate on top of carriage; R, rail; S, spring terminal of coil; T, tubular electric coil.

patent will, in connection with the explanatory notes thereon, enable the construction and operation to be sufficiently understood.

A French patent granted to Bonelli on the 18th day of December, 1861, No. 52,301, is for practically the same system as that shown in the English patent. The drawing, however, is somewhat different, since it shows a continuous tube surrounded at intervals by the wire coils. The sketches below are taken from the French patent. In both the patents



C, contact; C, carriage; R, rail; W, coil; T, tube,

above referred to, a battery is shown on the travelling carrier for energising the coils; but the suggestion is also made that a stationary battery could be used.

An Italian patent granted to Giovanni Minotto on the 31st day of December, 1861, is for what is termed an "electrical post, or a new method of transporting letters, packages and persons by means of electricity."

In this patent are found a series of hollow helices of insulated wire, each of which encircles the track, and a wheeled carrier moving them. One of the terminals of each coil is connected with a line wire leading from one pole of a stationary battery, the other pole of which is connected with the ground. The iron carrier is provided with a contact device on its top, which serves to close the circuit through the particular coil in which the carrier has entered the rails and ground, serving as the return conductor. It is stated that the entire system may be arranged on the ground or supported on posts; also that when passengers are to be transported, openings for ventilation and light are provided, together with brakes for arresting the motion of the carrier or train of carriers. It is also mentioned, that on inclines a greater number of coils are used, and that the battery power is increased; furthermore it is stated that the carrier can itself be converted into an electro-magnet by surrounding it with a wire coil through which a battery current is constantly passed.

The foregoing references clearly show that there is not much novelty in the system and experimental plant erected by the New England Port-electric Company at Dorchester, Mass. Engineering skill was, of course, required to bring said system into existence, and, as with many other electrical inventions, it required the modern dynamo to carry out the methods patented 30 years ago by Bonelli and Minotto.

MOLECULAR CHANGES IN METALS AS SHOWN BY THEIR ELECTRICAL CONDUCTIVITY.

DURING the last two or three years a great deal has been added to our knowledge of the constitution of cast steel and other important metals, and during the investigations which have taken place in pursuit of this knowledge some exceedingly interesting information has been acquired concerning the electrical behaviour of some of these metals at different temperatures.

Some time ago, Barrett observed that when a bar of hard iron is cooled down from a white heat there is a sudden development of heat when the temperature reaches that of dull redness, and at this point the magnetic properties of the iron suddenly change. He distinguished this phenomenon by the name *recalescence*.

The brothers Le Chatelier, Piuchon, Roberts-Austen, and others, have since Barrett's researches added some important contributions to our knowledge of this subject; but, especially, Osmond has succeeded in obtaining valuable experimental results.

In the *Comptes Rendus*, Vol. ciii., p. 743, there was a paper by Osmond on the heating and cooling of cast steel. These phenomena, it may be remembered, were investigated by means of a thermo-electric couple connected with an aperiodic galvanometer. Amongst the points brought out in this research we may note the following:—

As the proportion of carbon increases from 0·16 to 1·25 per cent., the temperature at which the molecular alteration takes place falls, whilst the point of recalescence rises until in hard steel the two points coincide. The rate at which heating takes place has no influence on the temperature at which the two changes occur, but these temperatures are

affected by the rate of cooling, and are lower the greater the rapidity with which the cooling takes place.

In quick tempering, no such phenomena are observed; the heat corresponding with the non-effected changes remains in the iron. During annealing after tempering, the latent heat of tempering is liberated gradually, and not abruptly.

In another paper, published in the *Comptes Rendus*, ciii., p. 1,135, Osmond described further experimental results of the same order, amongst which we may notice that for iron containing 0·16 per cent. of carbon there are, in cooling the fused metals, the following perturbations or points at which the rate of cooling diminishes, viz. :—

1.	Between	845°	839°	Centigrade.
2.	„	763°	749°	„
3.	„	693°	669°	„

These points indicate the formation of certain molecular modifications of the iron, each differing somewhat from the other.

The molecular changes are indicated by sudden change in the physical properties of the metal, and recently H. Le Chatelier has been endeavouring to make quantitative examinations of these changes.

Measurements of the changes in dimensions which accompany these molecular changes were first attempted, but without any satisfactory result, because of the very great experimental difficulties which were in the way. In one case, however, in a sample of steel containing 0·9 per cent. of carbon, a sudden increase in length of 1 mm. per metre was observed at the point of recalescence 730° Centigrade.

Measurements of the electrical conductivity led to more definite results—results which proved to be of an extremely interesting character. We may notice a few of them, but if our readers wish to study them in fuller detail they must consult the original paper by Le Chatelier in the *Zeitschrift für Physikalische Chemie*, viii., 183.

Metals which undergo no molecular changes when they are exposed to changes of temperature exhibit a conductivity which increases uniformly with the temperature.

The same law holds good, also, for the other metals above the temperature at which the last change takes place, for instance, for nickel above 340°, and for iron above 850° Centigrade. Below these points, the increase in electrical conductivity with the temperature is not uniform, but the temperature coefficient undergoes abrupt changes at certain places.

The point at which the molecular change takes place in the case of iron, namely, 850° Centigrade, is not altered by the presence of either large or small quantities of carbon and silicon.

The behaviour of iron and nickel alloys leads to the conclusion that the metals are not merely mechanically mixed, but have entered into more intimate combination.

A curious point was brought out with respect to ferro-nickel. A sample of this alloy containing 25 per cent. of nickel and 0·8 per cent of carbon shows, in its normal state, no point of molecular change above 0°, but when treated with moist hydrogen, which oxidises the carbon, it *becomes magnetic*, and on heating exhibits a molecular change at 550°.

ELECTRICAL WORKS FOR THE TWO TOWNS, BOZEN AND MERAN.

[FROM OUR OWN CORRESPONDENT.]

IN the well-watered and industrious dominion of the Austrian Crown, Tyrol, the realisation is at hand of a project very interesting in several respects, and which will soon find and will merit imitation in various directions. It is calculated to promote industry in extensive regions by the electric utilisation of water-power. The undertaking is to be executed conjointly by the two towns Bozen and Meran. Their object is the supply of electric light and motive power in the two towns which lie at the distance of 35 kilometres from each other, as well as in the adjoining country. It will probably not be devoid of interest to your readers to become acquainted with the report furnished by the Burgomaster of Meran, this official suspecting that the firm of Ammann, Musch and Lun, proprietors of the saw-mills at Aulose, were aiming at acquiring a control over the entire water-power of the river Adige.

To prevent this great water-power from being monopolised by private speculation, the Burgomaster, in conjunction with the magisterial councillors, Abart and Huber, bought certain plots of land in the Aulosen on behalf of the town.

During this transaction, Herr Hengstenberg, the proprietor of the local gas works, was present. On being sounded he expressed himself willing to treat with the town, Meran, for the substitution of the electric light for gas, and that he was willing to take part in the management of the future electrical works. It appears that he had been for years deeply engaged in the study of electrical affairs and that he had visited the Frankfort Electro-technical Exhibition in order to obtain a further insight into electro technics. Herr Hengstenberg expressed himself willing to negotiate for the conclusion of the gas agreement (which does not expire until 1903), and informed me that the engineer, Oscar von Miller, manager of the late Electro-technical Exhibition at Frankfort, was about to visit Bozen in October. By this opportunity he might be invited by the municipality of Meran to inspect the water-powers and give his professional opinion on their applicability for electrical purposes.

On the 5th of this month (evidently October ult.) I learned that O. von Miller would arrive on Friday, the 6th ult. He arrived, and in company with H. H. Hengstenberg, Abart, and myself, he visited the Töll and the Passer, and declared himself quite surprised with the favourable situation on the Töll, and that the available falls of this copious stream were likely to yield from 8,000 to 10,000 H.P.

He recommended the town of Bozen to undertake their intended water-supply (for electric lighting and for power) not on the Talfer, and not on the Cisack, but on the Adige on the Töll. He advised the town of Bozen to secure a share of this enormous water-supply, and pronounced it very advantageous if the two towns would combine to erect the weirs, water-courses, and the station for the machinery, as a joint undertaking. From this point (the machine-house) each town would then construct and manage its works separately. He pointed out the great economy of this plan as compared with the waste incurred if each town derived its water-power separately. He declared that he would recommend the town of Bozen to obtain its power from the Adige on the Töll.

On Saturday, 7th inst., I received an invitatiom fron the Burgomaster of Bozen to come to Bozen for a conference.

Oscar von Miller explained his plans thoroughly and clearly, and they were favourably received. After a discussion the following fundamental resolutions were adopted :—

1. The towns, Bozen and Meran, unite in applying for a concession for taking the entire available quantity of water out of the Adige on the Töll (parish of Partschin) down to the mouth of the Passer, for the joint installation of works for the production of electric current for the purposes of lighting and the transfer of power.

2. The towns, Bozen and Meran, guarantee each other half of this water-power, and each will bear half the cost of constructing and maintaining the joint installation.

3. If the two towns agree on another proportion of the source of power, the proportions of the costs as mentioned in No. 2 will vary accordingly.

4. Commencing at the point where the electric current is produced (the machine house), the further conduction and use of the electric current is then the independent task of the two towns, each of which will arrange and conduct it at pleasure.

5. Each of the two municipalities is further at liberty to hand over its allotted share of the water-power, to other communities and to allow sleeping partners to enter into the undertaking, but it is not allowable for other communities or individuals to be admitted as open participants. The only open and responsible partners are the communities of Bozen and Meran.

I (the Burgomaster of Meran) explained that I hoped to obtain the acceptance of these proposals.

O. von Miller declared himself at once prepared to furnish to the towns of Bozen and Meran :—

1. Gratuitously a general project calculated to serve as a basis for the construction of joint waterworks for the production of electric current.

2. To work out a detailed project comprising :—

a. The water supply.

b. The generation of electric power for lighting and motive purposes.

c. The estimate of costs.

d. The plan of working.

This detailed project he will supply for the fee of 2,000-2,400 florins. In this sum the two towns will participate.

3. That he guarantees the accuracy of his calculations, and if requested he will personally undertake the execution of his project for the estimated price. He is also prepared to undertake the supreme direction of the buildings for a fee to be decided on.

4. He is independent of all companies for undertaking electric works or machines and will hence recommend only those machines, &c., which suit the systems accepted by the towns, Bozen and Meran. The system must not be chosen according to the capacity of certain firms, but the selection of firms should be in accordance with the system.

He will always be prepared to come at his own expense to Bozen and Meran to explain his projects before the councils or in public meetings of the citizens.

In view of the counter-project prepared by the firm, Ammann, Nusch and Lun, it was resolved at once to submit the plan to the Imperial Government at Innsbruck. On the 8th inst. I went to Innsbruck in company with Burgomaster Dr. von Braitenfeld, von Aufschnaiter, engineer-in-chief, and von Miller, and had the honour of an audience. O. von Miller explained to His Excellency the importance of utilising the water-powers of Tyrol as calculated to find employment at home for the population.

His Excellency received our memorial with interest, and promised to assist the communities of Bozen and Meran as far as possible in their undertaking.

THE ELECTROMOTIVE FORCE OF METALLIC SALTS.

COPPER.

AN exhaustive study of the electromotive force of metallic salts was undertaken some months ago by Mr. C. L. Speyers, of the University of Missouri, U.S.A., which has led to some important results. Some of these we have already noticed, and we now give a summary of the experiments and conclusions arrived at since our last notice.

Measurements of the electromotive force between copper and mercury in solutions of copper salts have been made by Mr. Speyers, assisted by Mr. C. M. Hibbard. An amalgam was used, and it was observed that whereas a trifling addition of zinc to mercury gave it an electromotive force equal to that of zinc, a much larger amount of copper was required to effect a similar result. The greatest satisfaction was obtained by having pieces of amalgamated (electrolytic) copper floating in the amalgam ; then the electromotive force of amalgam-mercury was sensibly equal to that of copper-mercury, provided no secondary action occurred, such as evolution of hydrogen, formation of copper oxide, &c., which secondary action, when not preventable, necessitated a replacement of the amalgam by a copper rod made of electrolytically deposited metal.

The method of taking the measurements previously adopted were slightly modified because of the use of a rod. The mercury was contained in the tube, the stopper with its cup being replaced by a cork carrying the copper rod insulated by a glass tube. The deposit which formed on the rod was removed after each measurement by polishing with ground quartz and clean rag, careful washing and wiping with filter paper.

Copper chloride was not available as an electrolyte, a film forming immediately upon the pure mercury, wherefore also all liquids containing the salt were excluded, such as solutions of salts of copper in hydrochloric acid. But hydrochloric acid, either alone or in combination with the other acids was used, and the solutions were made by one of the methods previously described in our notices of this work, and which may be consulted in detail in the *American Chemical Journal*, xii., p. 254.

A large number of measurements were obtained, but they were by no means so accurate as those made with zinc. However, by taking a reading immediately after the first rapid rise before the rod had time to tarnish, fairly consistent results were obtained. These results are given in the *Am. Chem. Journal*, xiii., pp. 473—4, in a series of tables which are too lengthy for quotation. But we may note the following general conclusions arrived at :—

1. The average increment of electromotive force is usually small ; whenever large it is positive, except with copper nitrate, zinc chloride, acetate and sulphate. But owing to the small initial value, dilution from $\frac{1}{2}$ equivalent to $\frac{1}{512}$th equivalent can increase the electromotive force over 43 per cent. ($\frac{1}{2}$ Cu Ac_2 + $\frac{1}{1}$ H Ac), or with the amalgam, over 36 per cent. when diluted to $\frac{1}{256}$th equivalent ($\frac{1}{2}$ Cu Ac_2 + $\frac{1}{1}$ HNO_3).

2. The electromotive force in hydrochloric acid is lower than in the other three acids, which form a group by themselves ; the somewhat low value of acetic acid being doubtless connected with the use of the rod, for in its acid mixtures this acid acts like nitric and sulphuric acids.

3. The electromotive force in mixtures containing hydrochloric acid is the same, or less, never markedly greater, than in hydrochloric acid alone. The other acids having an electromotive force nearly equal, their mixture indicates little.

4. Substitution of copper for hydrogen lowers the electromotive force very much, but excessive secondary action forbids numerical comparison.

5. In mixed solutions of two salts of different metallic and acid radicals, the electromotive force is only slightly greater than in the solution having the lower value, due consideration being taken of the weak nature of acetic acid.

6. The electromotive force of $\frac{1}{2}$ Cu R + HR′ is sensibly the same as in the $\frac{1}{2}$ Cu R′ + HR, the difference in concentrated solutions disappearing on dilution.

PAYING LOADS FOR STATIONS.*

"DOES electrical distribution pay ?" In answer to this question it may safely be asserted that where the business has been in the hands of competent and conscientious managers, and where there has been fair capitalisation, it is paying, and paying well. The experience which is now available as the result of ten years of active work ought to be a sufficient guide to the station manager, and if his own experience is not adequate, the means for supplementing it are now at hand. We are confirmed in these views in perusing the able paper read by Prof. W. D. Marks, supervising engineer and general manager of the Edison Electric Light Company of Philadelphia, before the recent Edison Convention in this city. In this paper, entitled "How to Get Paying Loads of Stations," Prof. Marks states that his station was started about two years ago, with the price per lamp hour fixed at 1½ cent, which would be the equivalent of gas at $2.25 per M. As gas was selling at $1.50 per M in Philadelphia, the company had to acknowledge that electricity cost more than gas and that it was a luxury. The deterrent effect of such an admission became so apparent that after a few months the price was reduced to ¾ cent per lamp hour, thus placing it on a par with the cost of gas. With the cost the same, and with the acknowledged superiority of electricity, the result was not long in making itself manifest.

On the vexed question as to who should undertake the wiring and who should pay for it, it is interesting to note the course pursued by Prof. Marks. His company did no free wiring, but at first furnished service, meter and lamps, free of charge. At the end of a year's trial of this system, they furnished only the meter free, and the consumer paid for service and the first installation of lamps ; and they still renew lamps free of charge, when not broken. The company preferred also not to do house wiring, and encouraged the establishment of wiring firms by the payment of 15 cents premium for all lights secured, with the result that 13 wiring

* New York *Electrical Engineer*.

firms are now engaged in this business in Philadelphia, all working according to the rules, and under the inspection, of the company. In the same way Prof. Marks encouraged the establishment of agencies of the various motor companies, with the result that no less than 19 motor firms are represented in Philadelphia. These, together with the wiring firms, constitute no fewer than thirty-two active canvassing agents, who make a profit if they secure customers for the Philadelphia company, but who receive no salary whatever. The company sells power for all 110 volt motors at lamp rates; for 220 volt motors the rate is 7½ cents per horse-power hour. If a consumer takes more than 1,000 horse-power hours, and less than 1,500, the price is fixed at $75 per month; all power above $1,500 is sold at five cents per horse-power hour. Prof. Marks also points out in his paper that motors which run during the day, say from 7 a.m. to 6 p.m., are advantageous as giving the machinery of the station a uniform load, but in winter, when the lighting begins at 4.30 p.m., they overlap the lighting load, making a maximum load occurring between 5 and 6 p.m., and sometimes a very high maximum as compared with the average load. Small factories, business houses, stores and buildings used for offices, closing at 6 p.m., all add largely to this maximum load without burning on an average more than 1½ hours in 24, and for this reason should not form too large a proportion of the station load. With 55,064 lamps connected, each lamp yields a gross income of $51\frac{4}{10}$ cents per lamp per month, or $1\frac{71}{1000}$ cent per day, the average burning of each lamp being $2\frac{56}{100}$ hours, giving an average selling price of $\frac{668}{1000}$ cent per lamp hour.

SOME RECENT EXPERIMENTS WITH DIELECTRICS.

MONS. JULIEN LEFEBVRE has recently been engaged in a very interesting piece of research which was reported to the Academy of Science on November 16th. He examined how the field of force due to a single electrified point was modified when a plate of insulating material was placed before it.

In these experiments the insulating plate had parallel sides. A large coulomb balance of the square pattern was employed. This was provided in the interior with a metallic layer placed in communication with the earth. It was also fitted with a long window on one side for the purpose of facilitating the observations. The ball, which is usually fixed, was movable, and could describe a horizontal straight line parallel to the window and was carried by a needle 45 cm. long, which was itself supported by two fibres about 75 cm. in length. The needle was perpendicular to the plane of the window when there was no torsion on the fibres, and it carried a small plane mirror which enabled the observer to verify by the method of Poggendorf whether this condition was fulfilled.

The balance also contained a compensator consisting of two balls, or of one ball and a plate so arranged with regard to the two principal balls that they neutralised the action of the walls of the cage upon the needle. These four parts of the apparatus could be put in contact with one of the poles of a Ruhmkorff coil, of which the other pole was put to earth.

The movable needle being at zero, that is to say, perpendicular to the window, and there being no torsion upon the suspending fibres, there was interposed between it and the fixed ball a dielectric with parallel faces, which was placed at right angles to the straight line joining the centres of the two balls. The needle was then charged, also the compensator, but not the fixed ball; an arrangement was made so as to maintain the needle at zero.

The fixed ball was then charged and brought to different distances from the movable ball. In each position the repulsion was balanced and the needle brought to zero by twisting the fibres, the distance being measured by means of a cathetometer placed horizontally before the window.

A series of similar experiments was made without any insulating plate being present. The torsions observed in the two series are subject to two corrections; the first referring to the reciprocal influence of the two balls was calculated by means of the method of electric images; the second by the torsion of the two filaments.

From the corrected results curves were constructed having for abscissæ the distance apart of the ball and for ordinates the corresponding torsions. On examining these curves it was observed that the introduction of the dielectric increased the action of the fixed ball, as if this ball was approached from a distance

$$\delta = e\left(1 - \frac{1}{K}\right),$$

which only depends upon the thickness, e, of the plate and its dielectric constant, K. The dielectric, therefore, is equivalent to a thickness of air $\frac{e}{K}$, and by measuring δ on the curves Mons. Lefebvre was able to obtain the dielectric constants of a large number of substances, including sulphur, paraffin, ebonite, glass, petroleum, essence of turpentine and carbon disulphide. These are tabulated in the *Comptes Rendus*, Vol. cxiii., p. 689, but the list is too long for reproduction here. In most cases the results agree sufficiently closely with those obtained by Gordon, but Mons. Lefebvre has proved also, in the case of sulphur, that the dielectric constant increases with the time.

If a single point (*sic*) of mass, m, be electrified, before which is placed an insulating plate of thickness, e, then it can be shown that the potential of the other side of this plate at a distance, d, from the point along the perpendicular drawn from it to the dielectric is represented by

$$V = \frac{m}{d - e\frac{K-1}{K}} = \frac{m}{d}\frac{1}{1 - \frac{e}{d}\frac{K-1}{K}}$$

$$\text{or} \quad V = \frac{m}{d}\left[1 + \frac{e}{d}\frac{K-1}{K} + \frac{e^2}{d^2}\left(\frac{K-1}{K}\right)^2 + \ldots\right]$$

Mons. Lefebvre has calculated the value of this potential according to the theory of Sir William Thomson, under the form of a development in series; but the form of the development presents with the preceding several differences.

1. The successive terms of this potential equation contain the successive powers of $\frac{K-1}{K+1}$ and not of $\frac{K-1}{K}$

2. They depend not only upon the distance, d, but also on the distance of the dielectric from the electrified point and this experiment does not confirm.

3. The most important term of this series namely $\frac{K-1}{K+1}$ is *nil*, whatever may be the value of d.

These differences, Mons. Lefebvre considers, do not appear to place Sir William Thomson's theory in agreement with experimental results, at least in the cases examined.

Mons. Lefebvre has also been studying experimentally the cases in which plano-convex or plano-concave "lenses" of insulating materials are placed in front of the electrified point and the results are a little less in numerical value than those obtained with plates of these materials.

AN ITALIAN PATENT GRANTED, IN THE YEAR 1866, FOR THE ELECTRICAL UTILISATION OF WATER-POWER.

BY A. M. TANNER.

THE utilisation of water-power through the medium of electricity forms the subject matter of a patent granted in Italy, on the 30th day of June, 1866, to Felice Marco, of Florence. In the description accompanying the patent it is stated that, "it is known that with a magneto-electric machine we can obtain electric currents of any desired strength. These are used for various purposes, but the movement of the shaft which carries the magnets is produced by steam, necessitating a cost of fuel. But if this machine is placed in a locality where the gratuitous mechanical force of water can be utilised, electricity is produced without cost by means of said machine. It can be conveyed by means of metal wires to points where it is needed for producing the electric light, and for operating electro-magnetic machines; these machines have up to the present time not been used

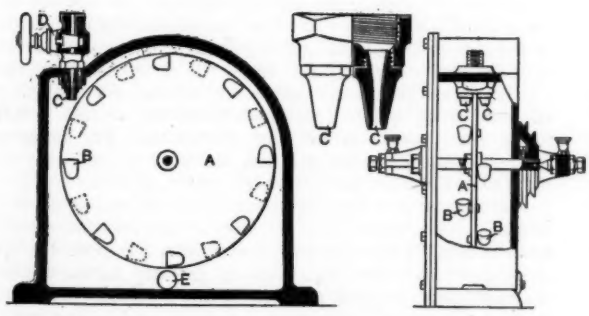
solely on account of the expense of the acids and metals required to produce the electric current, which far exceeds the cost of fuel used in steam engines. The application which I propose is, to produce the electric light gratuitously, and to permit the transportation of the mechanical force of waterfalls and streams of mountains and plains into a city by means of the magneto-electric machine. This is undoubtedly the most simple and rational solution of the problem of the production of electricity and of its application for the production of light, heat and force."

It will be seen that Marco clearly foresaw what is a *fait accompli* to-day, and according to the decisions of the United States Courts, his obtaining a patent was "a constructive reduction to practice of the method set forth in the patent, because he who makes the disclosure to the public in a patent benefits the public in this regard equally with him who makes the disclosure by actual reduction to practice."

THE "DEMON" WATER MOTOR.

MR. P. PITMAN, of Aubrey Road, Withington, Manchester, is making a very simple water motor which can be used for domestic and similar purposes. It consists really of an impact water wheel. The cups, B, are arranged round the periphery of the rotating disc, A, one on each side alternately. The water emerges through the two nozzles, C C, in a small

GENERAL VIEW.



SECTIONAL ELEVATIONS OF MOTOR AND NOZZLES.

stream, and by its impact on the cups drives the disc, A, round. The water finally escapes through the exhaust passage, E. The shaft which carries the disc, A, is held between adjustable centres as shown. The ordinary low pressure town's water can be used in driving this motor, and in starting or stopping it, all that is required is to turn the stop valve, D. There is no mechanism, such as pistons, slides or valves, to get out of order, and the water supply is the only expense.

It may be of interest to our readers if we give some examples of the uses to which the engines have been put, and the amount of water which they consume :—

Power.	Revolutions per minute.	Machine driven.	Gallons of water consumed per hour.
½ man	2,500	Dynamo (10 candle-power) ...	150
1 man	1,400	Printing machine (3,000 memorandum forms per hour)	220
2 man	900	Chaff cutter	260
5 man or 1 horse	...	Baling press	350

ON THE UTILISATION OF NATURAL FORCES AND THE ELECTRICAL TRANSMISSION OF POWER BY GRAMME DYNAMOS.

BY A. M. TANNER.

IT is well known that when the principle of the reversibility of dynamo-electric machines was practically demonstrated at the Vienna Universal Exposition of 1873, a Gramme machine used as a motor to work a pump was run by the current produced by a similar machine connected by cable conductors, and put in motion by a gas engine. This was an illustration of the electrical transmission of mechanical energy to a distance; but, obviously, fuel was required to operate the prime motor. It does not appear that the electrical utilisation of natural forces was suggested or proposed in 1873 in connection with the reversibility of the Gramme dynamo; neither does it appear that Gramme or Fontaine were aware at that time of the published descriptions of Bessolo in 1855, Cazal in 1864, and Marco in 1866, concerning the driving of magneto-electric machines by water-power, and the utilisation of the currents produced for working distant electric motors. Whether the utilisation of natural forces by Gramme machines is an invention, or not, need not be considered in the historical treatment of the subject.

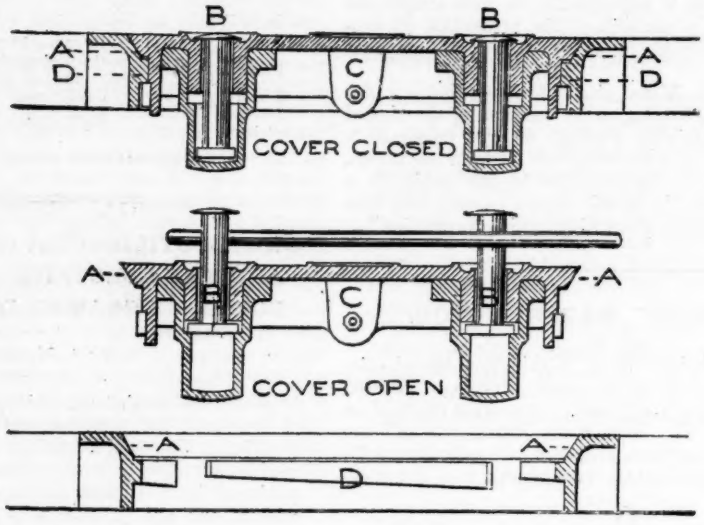
An Italian patent granted September 30th, 1874, to Francesco Ferrara-Bracco, of Palermo, has for its subject matter the electrical utilisation of water and other natural forces by means of Gramme dynamo machines. After describing the Vienna experiments, the patentee states that his invention consists in the electrical transmission of energy over long distances, and the utilisation of all kinds of natural forces. He specially describes the operation of a Gramme generator by means of the power derived from a waterfall and the conveyance of the electric current to distant points for operating other Gramme machines as motors. The description states that "to obtain a practical and useful application of the reversibility of the Gramme machine, it is necessary to dispense with combustibles. Natural forces, such as streams and torrents, can be electrically transmitted by means of the Gramme machine, and the current produced by the same subdivided, in large and small industrial establishments, for the production of motive power." It is also stated "that the electric current goes through wires suspended like telegraph wires, and is subdivided and transmitted to the Gramme machines (motors) in many ways."

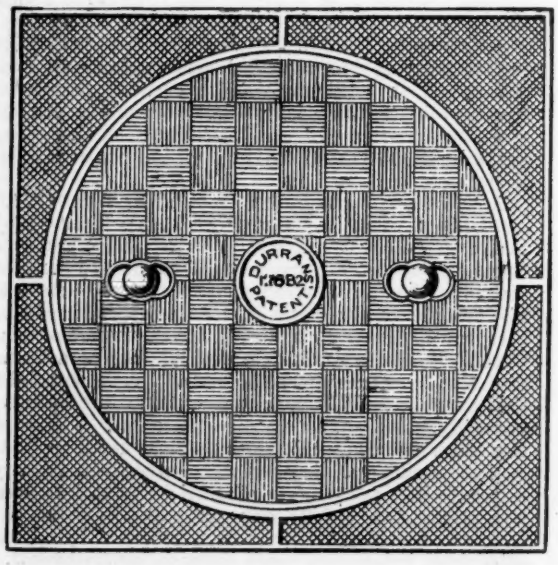
From the foregoing description it will be seen that Ferrara-Bracco had in the year 1874 a clear conception of the long distance electrical transmission of energy as subsequently carried out at Miesbach, Creil, and elsewhere.

Institution of Electrical Engineers Students.—A meeting of the students of the institution was held on Friday November 27th, when a paper was read on "Electric Mains for the Distribution of Light and Power," by Messrs. Griffin and Minshall. The next meeting will be held on Friday, December 11th, when a paper will be read on "Measuring Instruments," by Mr. W. A. Vignoles.

THE "KALLIO" METALLIC JOINTED AIR-TIGHT COVER.

THIS device, patented by Mr. Durrans, is for closing manhole chambers and electrical drawing-in boxes which require to be hermetically sealed. The invention consists in the cover and frame having a turned and ground bevelled face, A, which is truly seated by a vertical guide-joint, D, and brought together by a bayonet joint fastening as shown in the sections.





To open the cover the two drop handles, B, B, are lifted from their air-tight pockets, and any bar of iron or stout implement serves as a lever to turn and open the cover with ease. It is securely locked when down, as it cannot be opened without the lever. This is claimed to be the only cover extant which is absolutely air, gas, and water-tight (under pressure), *without the aid of perishable packing or jointing material of any kind.*

It can be seen, and particulars obtained, of Messrs. Durrans & Co.

REGULATION IN ALTERNATE CURRENT WORK.*

By J. R. CRAVATH.

THE necessity of paying careful attention to the regulation of a constant potential system is generally, from the nature of the case, felt more with direct than with alternating systems. I think it is safe to say that many of the stations now using the alternating system run on the plan of keeping the primary station voltage constant without regard to the load; and that at least some manufacturers wink at this state of affairs is shown by the fact that station pressure indicators have been turned out for use with a certain company's alternating apparatus, on which the scale consists of a simple scratch, at which point "tradition says" the voltage should be kept. A direct current station run on this principle of keeping the station voltage constant for all loads would (unless the line loss was smaller than it ever is in practice) soon have to quit the business on account of the lamp breakage during light loads. It is only because the loss between dynamo and lamps is comparatively smaller in the alternating system that superintendents are not forced to be more careful about their regulation. The industry has now come to the position that the small things count for more than formerly, and we cannot be too careful.

Assuming that a full load drop of two per cent. is allowed in the primary mains, two per cent. in the transformer and two per cent. in the secondary mains (this is a perfectly fair every-day case), then with constant primary station voltage the maximum variation possible on any secondary is six per cent. at the lamps! Supposing that the load on any transformer varies as does the entire load of the system from full to one-sixth load at different hours of the day, the regulation on that transformer can, of course, then be perfectly effected by dropping the station voltage five per cent. at light load.

And here comes in the real problem, viz., how to distribute the loads on the various transformers so that the load on one transformer will correspond approximately with that on the whole system. Of course to do this we must do a good deal of planning, and there is more carelessness in this respect

* New York *Electrical World.*

than in any other. The constructing engineer is apt to be above such work or think it is not worth attention, and it is a pretty universal custom (outside of the large plants under regular engineers), to cut in a transformer wherever and whenever more lights are wanted.

It will generally cost a little more work to distribute the transformer loads according to a system, but it can be done and pays abundantly on account of the better regulation possible, and any experienced station manager knows what good regulation means. The use of large transformers will help greatly by bringing different classes of customers on one secondary, so that there will be some all-night lamps on each transformer. This, as well as the greater efficiency of large transformers, has induced wide-awake superintendents to begin to use the larger sizes, for although it is yet to be proved that they are in themselves better regulated, yet, as I have shown, better regulation is possible with them if they are properly loaded to correspond with the loads on other transformers of the system.

The main difficulty comes with the lighting of residences and very much scattered buildings, where each house must have its transformer, which is fully loaded only on special occasions. It is generally advisable in such cases to wire the secondaries, so that the lamp voltage is normal when the transformer is half loaded, rather than run the few lamps that constitute the regular load at five or six per cent. above normal for 350 nights in the year in order to have the voltage exactly right the other 15. The plan proposed would limit the variations at the lamps to within two per cent. of normal, which is as near as we get with ordinary commercial instruments. It would help electric light men if a better knowledge was had of the transformers they use, and I hope the day is not far distant when more extensive data will be furnished with each transformer than its capacity in "16 C.P. lamps." There are hundreds of the smaller and moderate sized alternating current stations over the country which can profit by the observance of more system in their load distribution.

SIR WILLIAM THOMSON.

ON Friday, November 28th, a portrait of Sir William Thomson, subscribed for by a number of friends to signalise his election to the office of President of the Royal Society, was presented to the Glasgow University by Mr. A. J. Balfour. The hon. gentleman said :—"Sir William Thomson has been identified with the University from his very earliest years ; since the year 1831 he had been, either as a student or as a professor, almost continually concerned with the affairs of that great teaching institution, and he showed, even at an early age, what power he had of dealing with those scientific questions which it has been his great glory to solve. He is one of the very greatest men of science which, in my judgment, so far as I am able to give a judgment on the point, this country has ever produced. The unceasing and astonishing activity of mind which he has displayed on all subjects is familiar to all who have the honour of his acquaintance, but the results to which that activity has led are what really secure him the title to the gratitude of this generation, and to the fame in generations to come. He is another proof, if further proof were required, that the advancement of industrial invention is no bar to triumphs in the most abstract region of scientific research, and that the genius capable of dealing with the most abstract questions of mathematical physics may nevertheless condescend to subserve the material interests of mankind in a manner which, perhaps, those who devote themselves entirely to its interests are seldom able to equal. I, for my part, do not conceal that it is as the man of science rather than as the inventor, that I admire Sir William Thomson. As an inventor he stands in the very first rank of living inventors, and we all of us in our daily life, unconsciously perhaps, are gaining by the work which he has done in electrical and other matters, into the details of which I do not mean now to enter, but which have advanced the practical means of commercial telegraphy to an extent which, I think, only those who have carefully studied the subject are able practically to estimate. I hold this as an article of my faith, that knowledge, as knowledge, quite irrespective of the practical results which may be obtained from it, is almost the highest product which man, as an intellectual animal—as an intellectual being—is capable of pursuing. But even those who do not agree with that estimate of the comparative value of the different objects of human ambition will, at all events, agree with me that when this great speculative intellect is associated with powers which can be used, and in this case have been used, to advance the most obvious material interests of the country, the man who is possessed of these powers and so uses them is worthy not only of the highest admiration, but of the deepest gratitude of mankind."

PICTORIAL TELEGRAPHY.

THE advent of the telephone, which enabled us not only to converse through hundreds of miles of wire, but to recognise the voices of our friends, and the report of a few years ago that one's autograph could be faithfully reproduced at the distant end of a line (now an accomplished fact), set us all to wondering, says our New York exchange, *Electricity*, if the time would not come when we should see by electricity. On account of the subtlety of the light vibrations, compared with which those of sound are crude, it seems exceedingly improbable that the latter will ever be accomplished. But there has recently been invented a process by which photographs can be transmitted to any distance and reproduced at the further end in the form of half tones, similar to the photographic reproductions so much used in illustrated journals. This process is the invention of Mr. N. S. Amstutz, of Cleveland, O., and is known as the Electro Artograph.

The process is founded on the use of undulatory or varying currents of electricity, somewhat on the principle of the telephone—the transmitting instrument being actuated indirectly by the varying degrees of light instead of by sound waves, as with the telephone transmitter. To send a view or a portrait it is photographed on what is known as a "stripping film," composed of gelatine and bichromate of potassium. This mixture, as is well known, is sensitive to light, becoming exceedingly hard and insoluble when exposed, but readily dissolved where shielded from the light. A picture having been taken on a film of this kind, either by exposure in a camera, or, preferably, by printing through a negative, it is carefully washed with lukewarm water, which removes the portions not acted on by light, and leaves the other portions in relief. So far, there is nothing new in this process, which has long been used for newspaper work, and forms no part of Mr. Amstutz's invention. By this operation the amount of relief is in exact proportion to the light which has acted upon the gelatine, and there is produced a variable surface representing in elevation all the variations of light and shade of the picture.

This film is now stripped from the glass plate and mounted upon a sheet of celluloid, which is wrapped around a perfectly true cylinder, mounted on trunnions, so as to permit of revolution. In front of the cylinder is placed a bar, upon which rides a carriage containing a tracing point, which bears lightly upon the gelatine print, just as does the stylus of the phonograph upon the wax cylinder. In the latter the needle trips over the indentations produced in the wax by sound waves, and reproduces them in kind. In the former it rises and falls according to the greater or less relief due to the varying degree of light to which the film has been exposed, and by so doing varies, in a corresponding degree, the intensity of the electric current which actuates the receiving instrument. Thus far the analogy is very close to a telephonic transmitter, actuated mechanically by the diaphragm of a phonograph. It is clear that if this current can be caused to vary exactly as the elevations over which the stylus passes, the varying strength of the current at the distant point, if plotted, would be an exact fac-simile of the path described by the needle, or, as engineers would say, it would reproduce the profile of the path originally described. Now a single line does not make a picture, although it may form one element of a picture, as it does in this case. To transmit the picture, therefore, the whole of the gelatine film is gone over, the stylus describing a spiral around the cylinder with its returning paths quite close together, just as the phonograph stylus describes a spiral from end to end of the wax cylinder, and this is accomplished in exactly the same way.

Now, if the carbon button, which permits of sufficient variation in current for the transmission of speech, permitted of sufficient variation for this purpose, there would probably be no better way of varying the current than by its use, but carbon has not this flexibility, and Mr. Amstutz had recourse

PICTORIAL TELEGRAPHY—FIG. 1.

to another method. The "tracer," as he calls his stylus, is mounted upon a lever, which largely multiplies its up and down movement. This engages with a series of levers mounted on a common shaft, the further ends of these levers being platinum pointed, and serving, when depressed, to

REDUCTION OF FIG. 1, MADE AFTER TRANSMISSION.

connect the source of current with the line wire. The current enters the machine through this common, or tappet shaft, as it is called, and passes to line through the one or more contact points that happen to be depressed into contact with a plate connected with the line wire.

The action is this: Supposing the tracer were on a point of highest relief, only one of these levers would be depressed and the current would have but a single contact to pass through. Supposing, now, the tracer came across a place with slightly less relief, a second lever would be depressed, decreasing the resistance and permitting more current to pass, and so on until on passing a point of lowest elevation on the gelatine print, all of the levers would be depressed, reducing the resistance to the minimum and permitting the maximum current to pass. Of course, the more of these levers there are, the more gradual the variation of current strength sent over the line. The number of these levers or tappets is not limited, but may be anywhere from two to fifteen or twenty, or more, according to the character of the work to be done. The larger the number, the greater the accuracy of the reproduction. For long-distance transmission, especially for newspaper work, a large number of tappets is not desirable, since the degree of delicacy obtained thereby would certainly be lost on the rough paper and in the rapid press work to which it would be subjected; for all practical purposes a less number of tappets would produce equal results in this kind of work. Furthermore, the adjustment of the sending machine to the varying thicknesses of different gelatine prints does not affect in any manner the receiving machines, so that a picture sent with great delicacy may be received in the newspaper office in sufficiently crude form for its purposes, whereas another machine connected with the same wire and receiving the picture at the same time could reproduce it with the same delicacy with which it was sent—all depending upon the adjustment of the receiving instrument.

The receiving machines are duplicates of the sending machines as far as the cylinder, the carriage, feed, &c., are concerned—the only difference being the graving arm, which is depressed by an electro-magnet whose strength varies as the current by which it is excited. It is clear that when the transmitting instrument is passing over a low place in the gelatine film, and all the contacts are down, permitting the maximum current to pass, the electro-magnet of the receiving instrument will be at its maximum strength, and the graving tool correspondingly pressed on the receiving matrix, and *vice versâ*. The receiving cylinder is wrapped with paper covered with a suitable thickness of hard wax. This wax is turned off by a turning tool preparatory to use, just as is the cylinder of the phonograph, and when the impression is complete the waxed paper cylinder is removed, cut longitudinally and rolled out flat, and is ready for the electrotypers.

As an illustration of the manner in which a picture is received, let us assume an hypothetical case. Suppose the wax used to be white and we colour its surface black. Suppose the cylinder to be started and the graving tool but slightly depressed. A very delicate white line with slight depth will be traced. If the same pressure be maintained for several revolutions, there will appear a series of delicate white lines running closely parallel to each other. Now suppose the tracer on transmitting instrument to be passing over a portion of the gelatine print of greater depth, more current would be transmitted, and the triangular shaped graving tool would cut deeper into the wax, the white line would be broadened and the intervening black line made correspondingly narrower. A step further; when the tracer is passing over those portions of the film that are not intended to print at all, the graving tool will be buried so deeply in the wax as to cut away the black entirely, and in the electrotype made from this matrix this portion would be entirely cut away, so as not to print at all, thus producing in metal a line fac-simile of the gelatine relief from which it was originally produced. Thus it is seen that by variations in pressure of the graving tool all the gradations of light and shade found in the picture on the transmitting instrument may be faithfully reproduced on the receiving cylinder, and then in metal by the electrotype process.

Mr. Amstutz has also succeeded in reproducing impressions in papier maché directly from the wax, so that the engraving can be directly stereotyped in the ordinary manner.

The time occupied in transmitting an ordinary column-wide illustration need not exceed eight or ten minutes, and the stereotyping of the reproductions should not occupy more than a few minutes more, so that the reproduction can be placed upon the newspaper printing presses along

with the press despatches descriptive of the subject to be illustrated.

By a system of gears on both the transmitting and receiving instruments, it is possible to change the size of the picture at either end of the line. That is to say that a picture can be transmitted either larger, the same size, or smaller; and at the receiving end, if there be several instruments, they may each reproduce it on a different scale. Of course much greater accuracy is attained if large originals are used and they are reproduced on a smaller scale.

PICTORIAL TELEGRAPHY—FIG. 3.

A single transmitting instrument is capable of actuating a large number of receivers at different points; thus the same picture may be simultaneously reproduced at a number of widely-scattered news centres.

PICTORIAL TELEGRAPHY—FIG. 4

If it is desired to send hand sketches, a process has been devised by which a special artist can make his sketches "on the spot" by suitable washes, preserving all the half-tones that he may deem necessary to the correct pictorial representation, and upon the completion of the sketch it is wrapped round a transmitting cylinder, and by a simple adjustment of the tracer, the machine can be left to itself until the whole picture has been transmitted to its destination, where it is automatically reproduced, a complete line engraving.

It is claimed for this process that the depth of engravings can be increased over 100 per cent. above that reached by the deepest half-tone engravings, thus adapting the work to uses for which the latter, on account of their shallowness, are unsuited.

Besides the use of wax as a receiving substance, Mr. Amstutz says it is quite possible to engrave directly on metal; and he expects to find large application of his device for reproducing portraits, photographs, and conventional designs, both singly and in multiplicate, on silver and other metal ware, principally at local points.

We have been fortunate in securing some of the very first results of the work of the Electro-Artograph, which show better than the more finished productions the operation of this process. Each of these was transmitted a distance of 20 miles over a single wire with a 110-volt current. These cuts will increase in interest as the years go by, and are therefore worthy of preservation.

The latest addition that Mr. Amstutz has made to his invention is a system using alternating currents, by which it is possible to carry on pictorial transmissions over very long distances.

THE ROYAL SOCIETY.

NOVEMBER 30th being St. Andrew's Day, the anniversary meeting of the Royal Society was held in their apartments at Burlington House.

The PRESIDENT (Sir William Thomson) in his address referred with satisfaction to the institution during the past year by the Royal Commissioners of the 1851 Exhibition of Exhibition Science Scholarships, to which, after the first year, an expenditure to the extent of £5,000 is to be devoted. Sixteen appointments have already been made to scholarships of £150 to be held for two years, with a possible renewal for a third year. Candidates must show capacity for experimental work, and must, while holding the scholarships, continue to promote some department of science by such work.

Among the most interesting scientific events of the past year was the celebration of the 100th anniversary of the birth of Faraday, by the two Faraday lectures in the Royal Institution last June.

The President then proceeded to present the society's medals to the candidates to whom they have been awarded. The Copley medal was presented to Stanislao Cannizzaro, senator of Italy, and professor of chemistry in the University of Rome, who has rendered invaluable service to the philosophy of modern chemical science. A Royal medal was presented to Prof. Charles Lapworth, F.R.S., author of some of the most original and suggestive papers which have appeared in the geological literature of this country for the last 20 years. Prof. Rücker, F.R.S., was also awarded a Royal medal. Special reference was made to his researches in liquid films, to his manifold researches in electricity and magnetism, and to the completion by Prof. Rücker, in conjunction with Prof. Thorpe, of a magnetic survey of the British Isles (1884—89). The Davy medal was awarded to Prof. Victor Meyer, who now occupies the chair of Bunsen, at Heidelberg.

The society next proceeded to elect the officers and council for the ensuing year. The following is a list of those elected:—President, Sir William Thomson, D.C.L., LL.D.; treasurer, John Evans, D.C.L., LL.D.; secretaries, Prof. Michael Foster, M.A., M.D., and Lord Rayleigh, M.A., D.C.L.; foreign secretary, Sir Archibald Geikie, LL.D.; other members of the council, Captain William de Wiveleslie Abney, C.B., William Thomas Blanford, F.G.S., Prof. Alexander Crum Brown, D.Sc., Prof. George Carey Foster, B.A., James Whitbread Lee Glaisher, D.Sc., Frederick Ducane Godman, F.L.S., John Hopkinson, D.Sc., Prof. George Downing Liveing, M.A., Prof. Joseph Norman Lockyer, F.R.A.S., Prof. Arthur Milnes Marshall, D.Sc., Philip Henry Pye-Smith, M.D., William Chandler Roberts-Austen, F.C.S., Prof. Edward Albert Schäfer, M.R.C.S., Sir George Gabriel Stokes, M.A., Prof. Sydney Howard Vines, M.A., and General James Thomas Walker, C.B.

THE ANNIVERSARY DINNER.

In the evening the Fellows of the Royal Society and invited guests dined together in the Whitehall Rooms of the Hôtel Métropole. The company numbered over 230. The chair was occupied by the President, Sir W. Thomson, who had on his right Sir. J. Fergusson, the Italian Ambassador, Sir W. Bowman, the Greek Minister, Sir James Paget, Sir R. Herbert, and Sir J. Lubbock; and on his left Prof. Huxley, Mr. Forwood, M.P., the Danish Minister, Sir C. Tupper, Dr. John Evans (the treasurer), Sir R. Welby, Prof. Jebb, Sir A. Blackwood, and Mr. Briton Riviere.

The PRESIDENT, in responding to the toast of the "Royal Society," said that the next 50 years would probably produce, in the science of dead matter, and in the science of living matter too, discoveries compared with which those of the last 300 years would ultimately appear to be small indeed.

LONDON COUNTY COUNCIL.

THE following matters were reported at the weekly meeting held on Tuesday.

Loan to the Vestry of St. Pancras.

We have acted on the permission of the council to consider further the application from the vestry of St. Pancras, for sanction to borrow, and for the loan of £60,000 for electric lighting works, to be repayable in 42 years. We reported on the cost (£62,999 7s. 5d.) of the proposed works on November 17th, and recommended a loan of £56,300, repayable as to certain parts in varying periods of 5, 8, 15 and 30 years, such varying periods being fixed on the advice of the engineer with reference to the probable life of the work on which the expenditure would be made. Consequent on the discussion which took place at the council on the 17th inst., we have seen a deputation from the vestry, who have pointed out to us that the works as a whole will make up a permanent going concern, and must, whenever necessary, be renewed from time to time out of the vestry funds, so as to be kept always in good working order. We pointed out to the deputation that the council was, under its present powers, precluded from granting loans for works for a longer period than 30 years, except for street improvements and bridges; but while admitting this, they urged, in view of applications likely to be made by other parishes for loans to carry out similar works, that the council should obtain statutory authority to grant loans spread over a period not exceeding 60 years. Under these circumstances we consider that it will be better for the council to authorise the vestry to borrow elsewhere, than from the council, £60,000, leaving open the question of the council's advancing this sum, if Parliamentary authority is obtained for a longer period than 30 years. We therefore recommend (*a*) that the sanction of the council be given, under seal, to the borrowing by the vestry of St. Pancras of the sum of £60,000 towards defraying the cost of certain electric lighting works, at a rate of interest not exceeding £4 per cent. per annum, and the principal being repaid by equal annual instalments within a period of 42 years from the date of the loan. (*b*) That the council do apply to Parliament for power to make advances for electric lighting purposes to vestries and other rating authorities within the county of London, for periods not exceeding 60 years, and that it be referred to the Parliamentary Committee to take steps to obtain the necessary statutory authority for that purpose.

Mr. CAMPBELL said he would be the last to throw any obstruction in the way of so enterprising a parish as St. Pancras. The duty of the council with regard to these loans was to see that posterity was not unfairly burdened, and that the present generation were not allowed to play ducks and drakes with the money of posterity. The St. Pancras Vestry deserved the greatest credit for getting the provisional order to carry out their own electric lighting. In Kensington they did the same, but the difficulties and dangers seemed to them more than they were inclined to go in for. Electric lighting, he considered, could best be provided by private companies if they were not allowed too much tether, as the gas and water companies had been. They ought to recollect that a vestry had the authority to mortgage the rates. Electric lighting was comparatively in its infancy, and in the next 10 or 15 years heaven knew what the lighting of London would be. It probably would be electricity, he thought it would; still it was not yet so well established as gas was 20 or 30 years ago. The law was exceedingly defective with regard to these loans. He hoped the efforts of St. Pancras would be successful, and that other parishes would be induced to do the same thing; but he thought it fair, honest, and right that the council should discuss the matter fully, and that they should know what they were about before they put those burdens on the ratepayers of another generation. He moved that the report be referred back to the committee for further consideration.

Mr. WESTACOTT reminded the council that they were not agreeing to lend the St. Pancras vestry the money; they were only authorising them to borrow it for a period not exceeding 42 years.

Mr. CAMPBELL: On the security of the rates.

Mr. WESTACOTT asked whether it was not better for the parish, its ratepayers, and consumers that the vestry should undertake this work, when they could borrow at a low rate of interest, rather than that speculators should come in and by-and-by induce the council to buy the works at a large price. He hoped the council would encourage the vestry of St. Pancras.

Lord LINGEN, the chairman of the Finance Committee, said it was seldom that he appeared before the council to advocate a long in preference to a short period of repayment. His own opinion was most strongly, as a rule, in favour of short periods. That doctrine had not always been readily welcomed there, and he hoped after the feeling which had been shown on that proposal the doctrine would receive more favour in future. They had told the applicants that with their present powers they could not lend to them for more than 30 years. It was impossible for the council to shut its eyes to the fact that the example which St. Pancras set in that matter was an extremely important one. Parliament had expressed an opinion on the whole favourable—certainly not unfavourable—to the idea that the municipalities should undertake for themselves, and not leave to comparatively independent companies, such undertakings as involved the breaking up of the streets. That, on the whole, he thought, was a sound policy. Supposing St. Pancras did not go into the open market to borrow this money, the only alternative was that they must go to Parliament, and he himself rather leaned to the idea that they should go to Parliament, because, if they considered the magnitude of London and the enormous importance of the lighting of it, as to its being done in the most efficient and economical manner, he thought it really was a question of Parliamentary magnitude. The council, therefore, by adopting the recommendations of the committee, did not commit themselves to any very dangerous precedent.

The amendment was rejected, and the recommendations of the committee agreed to.

REPORT OF THE HIGHWAYS COMMITTEE.

London Overhead Wires Act, 1891.

By Section 5 of the London Overhead Wires Act, 1891, the council is empowered to make and vary bye-laws with respect to (*a*) the identification of overhead wires by registration or otherwise; (*b*) the regulation of wires; (*c*) the strength of the materials to be employed in placing, maintaining and supporting wires; and (*d*) the removal of wires erected or placed otherwise than in accordance with such bye-laws and of disused wires; and the council may by such bye-laws fix and determine the penalties to be imposed on the company or person failing to comply with any of the provisions of the Act, and continuing penalties in the event of any such offence being continued after conviction thereof. These bye-laws, are, however, to be of no effect until approved by the Board of Trade, which department is to prescribe to whom and in what manner notices of the intended bye-laws shall be given; and it is further provided that, before such bye-laws are proposed to the board for confirmation, notice thereof, with copies of the intended bye-laws, is to be given to the Postmaster-General. The general administration of the Act, and the enforcement of the bye-laws, when made by the council, and confirmed by the Board of Trade, devolve upon the local authorities, *i.e.*, within the City of London, the Commissioners of Sewers, and outside the City the vestries and district boards, except on the Victoria Embankment and the bridges which are vested in the council. We have prepared a series of bye-laws (a copy of which has been sent to each member of the council), and the Board of Trade has prescribed to whom and in what manner the notices of the intended bye-laws shall be given. It is probable that some exception may be taken, by companies and others interested, to some of the provisions contained in these bye-laws, and we are of opinion that we should have instructions to consider any suggested alterations, and to represent the council before the Board of Trade. We recommend that the draft bye-laws under the London Overhead Wires Act, 1891, be approved; and that it be referred to the Highways Committee to issue notices and to take all other necessary measures to obtain the confirmation of the bye-laws, including, should the committee consider it advisable, the employment of counsel to support the bye-laws before the Board of Trade.

Electric Meter Testing Station—Apparatus.

We have to report that it has been found impracticable to test with the current supplied by the Metropolitan Electric Supply Company, meters, of the pattern approved by the Board of Trade, sent in by the House-to-House Electric Light Supply Company, on account of the difference in the number of alternations used by the two companies; and that in order to overcome the difficulty it will be necessary to obtain an alternating current machine, driven by a motor, the cost of which will be £373 10s., and also a switchboard with the requisite connections, at a cost of about £55. It is expected that by means of this apparatus, in conjunction with that already obtained and at the station, electric light meters of any kind at present known can be tested; and we recommend that, subject to an estimate being submitted to the council by the finance committee as required by the statute, the Highways Committee be authorised to obtain, at a cost not exceeding £430, the additional apparatus above referred to, for use at the electric meter testing station.

Notices under Electric Lighting Acts and Orders.

We have considered three notices, with a plan attached to each, from the House-to-House Electric Light Supply Company, dated November 10th, 12th and 21st, 1891, respectively, of intention to lay electric supply cables (*a*) in a part of Earl's Court Square, (*b*) in Fopstone Road, and (*c*) on the south side of Old Brompton Road between Thistle Grove Lane and Drayton Gardens. The proposed works are of the kind approved by the council on previous notices of this company; and we recommend that the sanction of the council be given to the works referred to in the three notices, dated November 10th, 12th and 21st, 1891, respectively, of the House-to-House Electric Light Supply Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that no pipes of a larger diameter than 6 inches shall be used; that the street boxes shall be of the pattern approved by the council; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected with earth.

The Kensington and Knightsbridge Electric Lighting Company has given a notice, dated November 19th, 1891, of intention to lay mains in Kensington Square and King Street. These works are of the usual character; and we recommend that the sanction of the council be given to the works referred to in the notice, dated November 19th, 1891, of the Kensington and Knightsbridge Electric Lighting Company.

A notice, dated November 23rd, 1891, has been given by the Westminster Electric Supply Corporation, of intention to lay mains in New Tothill Street. The proposed works are unobjectionable; and we recommend that the sanction of the council be given to the works referred to in the notice, dated November 23rd, 1891, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the street boxes to be used shall consist of iron frames filled in with material to suit the paving.

We have also to report the receipt of the following notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid.

From the London Electric Supply Corporation.—November 14th,—To the Church of St. George, Hanover Square; November 17th—To 28, Golden Square; November 23rd—To 175, Oxford Street; 10 and 32, Glasshouse Street; and 22, Tooley Street; November 25th—To 67, High Street, Deptford; 65, Haymarket; and 19, 45, and 51, Tooley Street.

From the Electricity Supply Corporation.—November 14th—To Exeter Hall, Strand; November 20th—To 5, Agar Street; November 23rd—To 10, Agar Street; November 25th—To 2, Suffolk Place; November 26th—To 3, Suffolk Place.

From the St. James and Pall Mall Electric Lighting Company.—November 16th—To 21, St. James's Place, and 3 and 6, New Burlington Street; November 18th—To 6, Pall Mall; November 24th—To 161, Regent Street; November 25th—To 164 and 178, Regent Street.

LEGAL.

The Anglo-American Brush Electric Light Corporation v. King, Brown and Company.—This appeal, from the Court of Sessions of Scotland, was commenced on Tuesday last in the House of Lords before the Lord Chancellor, Lords Watson, Herschell, Field and Macnaughton.

The appellant's appeal against the interlocutors pronounced by the Lord Ordinary and the First Division of the Court of Session in Scotland, in an action of reduction of letters patent and relative specification.

The respondents state that the question raised in this action is whether the alleged letters patent, No. 2,003, of 1878, granted to Herbert John Haddan for an alleged communication from Charles Brush, abroad, and twice amended and disclaimed, are invalid; and the reasons for the respondents' case are as follows:—

1. Because the alleged inventor was not the first and true inventor of series shunt winding.
2. Because series shunt winding had been disclosed by publication prior to the date of alleged letters patent.
3. Because the same had at the said date been publicly used.
4. Because the commutator purporting to be disclosed in the provisional specification No. 2,003 of 1878 had previously been publicly used.
5. Because the provisional and final specifications are disconformed.
6. Because the subject matter of the fourth claim of 2,003 was not novel.
7. Because the interlocutors appealed against our will founded in fact and law.

The Solicitor-General for Scotland (Mr. A. Graham Murray) appeared as counsel for the respondents.

Reasons for the appellant's case are as follows:—

1. Because the said letters patent were always and now are valid in all respects.
2. Because the specification of S. A. Varley, No. 4,905, of 1876, does not contain the description of compound-winding, and does not anticipate the invention claimed by Brush in the said letters patent.
3. Because the machine made at Siebe and Gorman's works was an abandoned experiment and not a compound-wound machine, and was not published, and not a publication of compound-winding as claimed in Brush's specification.
4. Because the commutator claimed and described in Brush's said specification was duly and sufficiently foreshadowed and comprised in the provisional specification within the meaning of the law relating to letters patent.
5. Because none of the objections to the validity of the said letters patent, relied on by the respondents, were proved or capable of proof.

The Attorney-General (Sir R. Webster), also Messrs. J. Fletcher Moulton, J. C. Graham and A. R. Askwith appear as counsel for the appellants.

In opening the case for the appellants the Attorney-General stated that, the petition was based upon the ground of the petitioner being personally interested in the manufacture of dynamo machines. The petition alleged that the subject matter in the invention had been anticipated. The decision was in favour of the respondents in both courts, Lord Traynor and the Lord Ordinary holding that the patent of Brush had been anticipated. In one matter the First Division of the Court of Session supported the view as to that they had anticipated, but did not decide the question of the conformity. Of course it was open to the Solicitor-General of Scotland to obtain full ground before their Lordships' House. The case was one of extreme difficulty. It was a subject in which he had, so far as this case was concerned, not much knowledge, but he hoped to assist their Lordships. It was a case of very great importance, because it had a wider effect than an action for infringement of patent. There was no question that the Brush Company were possessed of a patent by Mr. Brush, the American, which did occasion a complete revolution on the one company as far as a development which introduced some very great improvements in the working of dynamo machines. There was no question of the date of the patent, which he would call "shunt series." Machines came into use, were made at once, and largely used.

Replying to a question as to whether the shunt series was of very special use except for electric light,

The Counsel said It was used for electroplating. On the face of the specification, the object was more for electroplating than electric lighting. There was no question whatever that it had caused a great development in electric lighting. The development of the improvement by Mr. Brush had a perfectly independent effect; that is to say, it had an effect in other operations besides electric lighting. There was no question that from its description of the invention a man would not only be guided, but directed in making such a machine. There was no question that the Brush specification of 1878 told people how to make a "series-shunt" machine. It was said that it was anticipated by a specification two years before by a very clever gentleman named Mr. Varley, of which specification it was said that beyond one machine made for experimental purposes, which was thrown on to the waste heap, nothing ever came of it. Of course there would be a contention, which their Lordships would anticipate, that the alleged anticipation did not describe their machine or come up to the rule (which had been recognised by their Lordships' House), that there must be a sufficient description to enable a workman to make the machinery. Nobody at that time would ever for a moment have thought that he was referring to a "series-shunt" machine. Moreover, they would see that the language did not infer that meaning.

The Lord Chancellor: Is the object the same?

Counsel: No, my Lord; in one object the same, but in the other very different. There was no question that Mr. Varley was inventing a large number of different types of dynamos; not by any means one type. They would suggest that he was expressing that he had no knowledge of the principal object in view, and had not some object in view at all. Whereas, on the face of Brush's specification, the cause was distinctly stated. One other thing he thought he ought to mention before going into details of the case, that as far back as 1852 Sir Charles Wheatstone, and, possibly, some other men—he thought Dr. Siemens—had worked in this direction.

This case was resumed yesterday morning, but when the House adjourned the Attorney-General had not concluded his address.

(To be continued.)

NOTES.

Direct Spanish Telegraph Company, Limited.—We are informed that direct communication with Spain *viâ* Bilbao on this company's cables is now restored.

Personal.—We hear that M. Alfred Potier, has been nominated as a member of the Institute (Academie des Sciences, Physical Section) in the place of M. Edmond Becquerel.

Telegrams to Peru.—Last Friday's *London Gazette*, announces that telegrams can now be forwarded to Peru by the routes of the Eastern and Direct Spanish Telegraph Companies, at the rate of 8s. 2d. per word.

Suggestive.—The gas supply of the Rhymney Valley, a populous colliery district in Wales, is conspicuous by its absence, and the inhabitants have decided to petition Parliament in the next session for a Bill to authorise the construction of gasworks. Here seems to be a good opportunity for the introduction of the electric light.

The Ideal Inventor.—Noah S. Amstutz, of Cleveland, the inventor of the process, described in our other pages, for transmitting pictures by electricity, says a Chicago paper, is a little man, with a full beard, and wearing iron-bound spectacles. For six long years he has followed his pet idea, until now he feels certain that complete success is about to crown his efforts.

Van Traction.—Messrs. Hazell, Watson and Viney, write to us as follows:—"Can your readers inform us whether it is yet practicable to convey a van, which with its contents, would weigh about five tons over a common road for 35 miles by an electric motor and accumulators. By "practicable," we mean at an average speed of not less than five miles an hour, at a cost considerably less than that of horses and without recharging the accumulators during the journey. We shall be glad to have any proposal on the subject."

The Electric Light in Schools.—We recently announced that Messrs. Drake and Gorham had fitted up the Felsted School with the electric light, this being the first in the country using such illuminant. A correspondent of the *Pall Mall Gazette* brings a statement to contradict the assertion, which was also made by our contemporary, and he refers to Blairlodge, the largest Scotch boarding school, which he states has been lit by electricity for seven years. At present the light is laid on in every part of the school buildings. Doubtless Messrs. Drake and Gorham referred to England only.

Telegraphic Extension in South America.—The *Diario*, the official Chilian journal, states that a concession has been granted to Sir John Pender, on behalf of the Eastern Telegraph and Western Brazilian Cable Companies, for a line from Valparaiso to the eastern Chilian frontier, where Sir John Pender has undertaken to make a connection with Buenos Ayres. The American cable companies will also continue their lines to Buenos Ayres from Santiago.

Electric Lighting for Hull.—We hear that at a meeting of the Electric Lighting Committee of the Hull Corporation on the 26th ult., a report presented by the sub-committee on the lighting of the town was adopted. The electrical engineer had presented a plan of the general arrangement and plant for the electric light station. The engines to be adopted are those of Messrs. Willans & Robinson; the boilers are return tube type, by Messrs. Davey, Paxman & Co.; and the dynamos are Messrs. Siemens' manufacture. The estimate of the whole cost of laying down the installation was £19,720.

Electric Lighting Troubles in Paris.—The electric lighting of Paris, like that of London, appears to be subject to a large number of obstacles, to judge from the following extract from *Le Soleil*:—Hardly installed on our boulevards, is the electric light already destined to disappear? In the First Civil Chamber, was begun the other day the hearing of a trial, in the course of which a grave question was touched upon. The inhabitants and shopkeepers in the neighbourhood of the Edison station, in the Cité Bergère, complained of the annoyance caused them by the installation of engines of 3,500 horse-power, and demanded the suppression of the station, without reckoning damages. Maîtres Duverdy, Josseau, Bonnet, Ferré, and Rousseau, appeared for the plaintiffs, and Maîtres Rendu and Dreyfus for the defendants, l'Assistance Publique, and the Edison Company. After a lengthened hearing the case was adjourned for a week.

The Electric Light at Bristol.—A correspondent writes as follows:—Mr. W. H. Preece, who is advising the Electrical Committee, visited Bristol on Saturday week and inspected the works now in progress. Mr. Preece has furnished a report dealing with the machinery and plant of the proposed installation. He recommends the adoption of the locomotive type of boiler, with which the capacity of the central station would be adequate for present wants. The capacity of the proposed plant to comply with the scheme laid down in a previous report was 10,000 glow lamps of 16-C.P., and 96 arc lamps for purposes of street lighting. The area proposed to be lighted exceeded, but would include the compulsory area of the provisional order, and it was presumed that gradually, as the business of the city developed, the whole of the city would be brought within the supply area. The cost of the production of energy is being reduced, and Mr. Preece quite believes that in Bristol it will be below the estimate contained in the report presented in December last.

A Story of a Tree.—*Le monde des plantes* is responsible for the following extraordinary story which purports to be a statement of facts. About two years ago, at the end of the month of September, a large tamarind tree was struck by lightning at Kumbakonam in India; and fifteen days afterwards the tree burst into bloom; but whilst every branch was laden with blossom not a leaf was to be seen. When the time came for its normal flowering, the tree developed a second crop of blossom, and then, as though exhausted with the strain, it died. We think it is scarcely allowable for our contemporary to argue from this isolated instance that the electricity had produced a sort of super-excited vitality. If such phenomena had been observed in a large number of similar instances, then some deductions might be attempted. As it is, the isolated fact proves nothing, and may be merely a remarkable coincidence, or an example of abnormal behaviour. Even though the tree had not been struck by lightning, an accident which we should have thought would have decreased its vitality, it might still have experienced this kind of abnormal flowering. How would our contemporary explain the following facts? The white hawthorn flowers in May, yet the Glastonbury thorn produces May-blossoms, almost unaccompanied by leaves, at Christmas time, and then flowers again in May.

The Electric Light for Manchester.—The *Manchester Guardian* states that complaints are being made as to the delay of the authorities in carrying out the scheme for the electric lighting of the central portion of the city. It was understood some weeks back that the whole scheme was ready to be carried into effect, but little progress has been made in the matter. The delay is attributed to some difficulty which has arisen as to the selection of a site for the generating station.

The Bermuda and West Indian Cable.—We extract the following from the New York *India Rubber World* of November 15th. "A new cable 1,200 miles long, between Bermuda and the united West Indies, is projected under the auspices of the Canadian Pacific Railroad Company. The company, it is reported, have the proprietorship of the cable between Halifax and Bermuda, and they intimate that a large reduction will be made in tolls between Canada and the West Indies, as well as between Europe and the United States. As the Western Union Telegraph Company have the distribution of messages coming over the cable from Halifax, and also at Jacksonville, Florida, it is not exactly clear how this sweeping reduction is to come about. A new route, however, will have been opened between London and Pará with a smaller number of relays than by the Lisbon way.

Telephone Circuit Wires.—Referring to the circuit wire described on pp. 461 and 575 of the ELECTRICAL REVIEW, where the call wire consists of a loop connected with the apparatus and the earth, Dr. Zetzche writes us from Dresden:—"I will call attention to the fact that I gave the same arrangement for fire service telegraphs as early as 1872, and that I briefly described it in my 'Catechism of Electric Telegraphy,' in 1882 (5th edition, p. 265, and 6th edition, p. 395). But as Lewis H. McCullogh patented in Germany a similar arrangement for fire, or telegraph signals, omitting the earth connection (No. 34,474, April 28th, 1885), I described both arrangements in full in the *Elektrotechnische Zeitschrift* (1886, p. 224), and explained them with a drawing, clearly pointing out their valuable features. This arrangement has therefore only been utilised for the telephone service wires. According to the explanation given, the adaptor had at that time no knowledge of it, and has accordingly invented it anew, and has followed the same track as I did. The arrangement of the telephone service wire quite agrees with the plans so much used in fire service telegraphs (see *Elektrotechnische Zeitschrift*, 1886, p. 224; *Katechismus*, p. 265 or 394), upon which I proceeded.

Telegraphic Delays.—The *Glasgow Herald*, in a recent issue, gives prominence to an article on the above subject. The whole matter is written with "Glasgow coloured" spectacles, and though there may doubtless be a good deal in what is said, the London officials who appear to be held responsible by the writer, would no doubt, if they had the chance, have a good deal to say from their point of view. The logic of the arguments is, in many cases, peculiar, for to prove one point it is stated that the quadruplex system when it breaks down is equivalent to two wires being closed for working, and to prove another point it is stated not to be equal to two duplexes, *i.e.*, *not* to be equal to two wires. Multiple systems, in fact, are lauded because they enable a large amount of work to be done on one wire, and thereby to bring down delays, and, on the other hand, are condemned, because when they break down serious blocks occur. In fact, logically, according to the writer only single worked circuits are the right thing to employ, there being enough wires erected to carry off all the traffic without delays when worked in this manner. What would be the result of such an increase of wires? Why, a more serious breakdown than ever should a heavy gale arise. The writer omits to state that the recent rough weather was of an entirely exceptional character, being such as had not been experienced for many years. It would also appear as if Glasgow were the only town of importance in the United Kingdom, and that unavoidable delays never occurred elsewhere. In our opinion articles of the kind in question are exceedingly unfair, as owing to the somewhat technical style in which they are written, the public are quite unable to see where the flaws in the arguments exist, whilst the plausible utterances often go home and foment unjustifiable discontent.

Cables Between Spain and Morocco.—The Spanish Administration announces the recent laying of a submarine cable between Tunara, near Alziaras on the Spanish coast, and Ceuta on Morocco coast. The system of which this line forms a portion, has also been augmented by the laying of cables on the coast of Morocco, between Melilla and Alhucemas, and *between* Alhucemas and Peñon de la Gomera.

Private Bills in Parliament.—The total number of provisional orders that will be applied for in Parliament next session, is not greater than 69; of these 30 relate to electric lighting undertakings, and 13 are for powers to light certain areas in London which are already allocated to other companies under provisional orders confirmed by Parliament in past sessions.

The Electric Light in Japan.—The Yokohama Electric Light Company is at present in difficulties. From the report of the committee appointed to enquire into the state of affairs, we learn that of the total capital of £30,000, £24,371 was paid up. The debts of the company amount to £10,425, and the average monthly expenses are £330, in addition to which £90 per month is required for interest, making a total monthly expenditure of about £420. Against this the monthly receipts only average £200, showing a monthly loss of over £200. No decision has as yet been arrived at regarding the future of the company, but the prospect does not appear to be a bright one.

Electric Tramcars at Croydon.—Last Monday afternoon, Major-General C. S. Hutchinson and Captain P. Cardew visited Croydon for the purpose of inspecting, on behalf of the Board of Trade, the working of a new electric tramcar, several similar to which are about to be adopted by the Croydon Tramways Company. The tramcar, which, when empty, weighs 5½ tons, is driven by two motors of 14 horse-power nominal, and can attain a *maximum* speed of 16 miles an hour. A trial trip was first of all made to Thornton Heath, after which the whole of the circuit to North-end, Croydon, was completed without a hitch, and the inspectors expressed themselves as being thoroughly satisfied with the experiment.

Dublin Electric Lighting.—We have referred to this matter several times within the last six months, and we are disappointed and surprised to learn that the electric lighting operations at Dublin are apparently not so well forward as we stated in our issues of September 18th and October 23rd. We now understand from *The Freeman's Journal*, that "it is hoped that the entire work will be completed by next April." We prefer to refrain from making any further forecasts as to when the work really will be finished. It is stated that the men are now engaged in opening the manholes preparatory to laying down the mains from which pipes are to run in different directions. This statement seems almost incredible, as on October 12th our contemporary, the *Dublin Evening Telegraph*, said that "in the course of a few days" the streets would be besieged by workmen for this purpose.

A Cable to the Bahamas.—The London *Times* of the 28th inst., contains the following announcement:—"Arrangements have been made for connecting the Bahama Islands in the West Indies with the general telegraphic system of the world and the mother country. The project consists in laying a submarine cable of about 200 miles in length from a point about five miles from Nassau, New Providence, to a point about the same number of miles from Jupiter Inlet, on the south-east coast of Florida. The cable, which has been designed for the government of the colony by Mr. W. H. Preece, F.R.S., the electrician to the Post Office, will be insulated with guttapercha, and is being manufactured by Messrs. W. T. Henley and Company. It will be laid in January or February next by the steamer *Westmeath*, belonging to that firm. As the Western Union Telegraphic Company's Floridan lines do not at present run so far south as Jupiter Inlet, the station at the American terminus of the cable will be in charge of the officers of the United States Weather Bureau, who will transmit the messages to the Western Union Company's system over their private line. Traffic between England and the Bahamas will thus pass through the Atlantic cables."

Colliery Electric Lighting.—Dumbreck Colliery, Kilsyth, which is one of the largest and wealthiest collieries in Scotland, is to be lighted throughout with electricity. The contract, which is a heavy one, has, we understand, been placed with a Glasgow firm of electrical engineers.

Electric Lighting in Christiana.—A Reuter's telegram, dated Christiana, November 27th, says:—The municipal authorities have concluded a contract with a Nuremberg firm for the supply of the necessary machines, accumulators, and cable for lighting this city by electricity. It is stated that the cost of the appliances amounts to 750,000 marks.

Electric Lighting at Brighton.—An important notice by the Brighton and Hove Electric Light Company was published on Saturday last. The company intend to apply to the Board of Trade for a provisional order to authorise them to lay down mains—not to erect overhead wires—in every part of the municipal borough of Brighton except the area now supplied by the Brighton Corporation.

Glasgow Corporation and Electric Lighting.—The Glasgow Town Council Electric Lighting Committee have made arrangements for the purchase of a site for the erection of buildings in which to place the electric plant for lighting the central area of Glasgow. The ground is situated in Bishop Street, Anderston, and the price to be paid is £8,000.

The Electric Light at Torquay.—Mr. Radcliffe, electrician, of St. Hellier's, Torquay, has recently carried out an installation at Mdlle. Schneider's Dancing Academy, in that town, and has successfully demonstrated that the electric light can be applied to small villa residences at a cost only a very little in advance of that of gas. Only the rooms on the ground floor of the academy are lighted with electricity, the lamps, 26 in number, being suspended from the ceiling and covered with prettily designed ground shades. The cost of the installation, inclusive of the steam engine, has been under £200. It is hoped that this installation will lead to the introduction of the electric light into a large number of villas in the far-famed Devonshire watering place.

The Law on Town Council Voting.—Mr. Garcke, managing director of the Brush Electrical Engineering Company, Limited, writes:—"At meetings of local authorities the question is from time to time raised whether members interested in gas undertakings are entitled to vote or take part in discussions upon electric lighting matters. It may be useful, therefore, to the electrical industry to know what the law on this subject is. Mr. Sydney Morse has had occasion to take counsel's opinion upon the point and as I have obtained the permission of his clients to publish the opinion (which he has obtained from Mr. R. S.—now Mr. Justice—Wright), I enclose it herewith, and trust that its publication by you may help to prevent the continuance of the injustice which is now frequently done to electrical companies by representatives of gas interest."

Opinion.—The Urban Sanitary Authority of . . . is the Corporation acting by the council (see S. 6 of the Public Health Act, 1875) and consequently the present question turns on the construction of s. 22 sub s. (3) of the Municipal Corporations Act 1882. In my opinion those members of the council who are shareholders in the gas company have a direct pecuniary interest in the question whether or not the council shall give their consent to the application by the electric light company for a license under 45 and 46 Vict c. 56, s. 3, and such members are not entitled to vote on the question or to take part in the discussion of it. No penalty is attached to a breach of s. 22, sub s. (3), and all that can be done in order to prevent such members from voting will be to get some member of the council to draw the attention of the Mayor to the fact that the votes in question ought not to be received and will be invalid. See rule 10 of the 2nd Schedule to the Municipal Corporations Act 1882.—(Signed) R. S. WRIGHT.

45 and 46 Vic. ch. 50 o. 22 (3). A member of the council shall not vote or take part in the discussion of any matter before the council or the committee in which he has directly or indirectly by himself or by his partners any pecuniary interest.

Horse Clipping by Electricity.—The horses of one of the tramway companies in New York are now clipped by a clipping machine operated by an electric motor. The power is conveyed to the clipper by a flexible shaft.

Pictorial Telegraphy.—We reproduce, this week, from an American exchange an article of much interest on the subject of the transmission of pictures of various kinds by telegraph. There have been several methods devised for transmitting line drawings by wire, but none, so far as we know, produce half tone effects.

Extension of Telegraphs in Spain. — Yesterday's *Evening Standard* states that the Spanish Government has completed a scheme for a considerable extension of the telegraph in Spain, and extensive operations are to be forthwith began. Several new direct lines will be laid, including one from Barcelona to Bilbao, to place the former town in direct communication with the cable to England, and another from Trun to the Portuguese frontier, which will place Portugal in direct communication with France. Fully 350 new stations are to be established, and the scheme also provides for the construction of a telephonic net to bring into inter-communication the towns of Seville, Huelva, Cadiz, and Malaga.

The City Lighting.—The decision at which the Commissioners of Sewers arrived on Tuesday regarding the application of the City of London Electric Lighting Company for an extension of time, will be found in our other columns. Why it was decided that the request could not be entertained *at the present time* is beyond our comprehension; a year hence, probably, no such application would be necessary. We believe that there is more behind the company's pretexts than meets the eye, but both the company and the Commissioners should have known earlier in the day that the lighting could not possibly be carried out by the date fixed; it would have been, therefore, more generous on the part of the latter to have graciously granted further time for a new and difficult undertaking.

The Efficiency of Electro-motors.—M. Hospitalier writes as follows in reply to a "Note" in last week's issue:—"If M. Gravier had taken the trouble to write to me direct, I could very easily have explained to him, without appealing to foreign arbitration, a contradiction which only exists in his imagination. The efficiency of an electric motor may be made as near unity as required by reducing the power produced, but if we wish to produce the maximum of power, the efficiency is not a maximum, but falls to 50 per cent. M. Gravier confuses the maximum efficiency and the efficiency corresponding to the maximum power. His age and his position prevent me from inviting him to attend my lectures or those of my colleagues, when he would soon be acquainted with a well-known fact, and convinced that there is no contradiction in the statements which he quotes, and no error beyond that which he has himself committed."

A Visit to the Elmore Copper Works at Leeds.—We cull the following from the *Financial Times* of Tuesday last:—"The shareholders of the Elmore Patent Copper Depositing Company are now to have an opportunity of seeing the ingenious and admittedly successful electric process in operation at the works near Leeds. They are to be taken by car-loads from London on the 2nd, 3rd, and 4th of December, and no doubt the trip will be a pleasant and instructive one. We doubt if it will make quite clear the still indefinite point as to the amount of the actual net profit earned on work already done, but the directors have always treated that as a detail, and the shareholders have acquiesced with wonderful docility. The offer to show the shareholders the works is very judicious and well-timed, but there is one unpleasant feature about the invitation. The secretary says:—'I may add that my directors have made arrangements by which no expense will accrue to the company from these visits.' That is very nice, but whose interest in advertising the Elmore process is greater than that of the company? Is the process being run for the benefit of third parties?"

Johns Hopkins University.—The Edison General Electric Company, of New York, through the influence of Mr. T. A. Edison, have presented two 15 H.P. street car motors to the electrical department of the Johns Hopkins Institute, at Baltimore, Md., U.S.A.

An Electrical Tramway for Warsaw.—A project for the construction of an electrical tramway in the town of Warsaw has been presented to the civil anthorities by Messrs. Siemens and Halske, of Berlin.

NEW COMPANIES REGISTERED.

National Telegraph Works Company, Limited.—Capital £5,000, divided into 990 ordinary shares of £5 each, and 50 founders' shares of £1 each. Objects: To enter into an agreement with J. S. Lewis, and to carry on business as electrical engineers and contractors, and manufacturers of electrical appliances, insulated wires, cables, insulating materials and other apparatus and things connected with the use of electricity. Signatories (with 1 share each): J. S. Lewis, The Swifts, Yardley, Birmingham (telegraph engineer); A. H. Church, 242, Frederick Road, Aston, Birmingham (electrician); J. H. Oglesby, Hurst House, Golden Hillock Road, Birmingham; E. Price, 21, Church Road, Aston; D. Dryburgh, 17, Suffolk Street, Birmingham; W. Squires, 91, Queen's Road, Aston; W. G. Cassini, Hurst House, Golden Hillock Road, Birmingham (electrician). The number of directors is not to be less than two, nor more than six, the first being the first two subscribers. Qualification, 50 ordinary or 1 founders' share. Registered on the 27th ult. by A. P. Honeyman, 9, Bennett's Hill, Birmingham.

Patent Electro-Magnetic Clock Syndicate, Limited.—Capital £25,000, in £1 shares. Objects: To acquire the interest in the invention relating to improvements in electrical appliances for which W. R. May has obtained provisional protection No. 12,150 of 1891; to acquire the benefits of a contract dated October 15th, 1891, between W. R. May and Albert Hoster; to adopt an agreement dated November 25th, 1891, between W. R. May and V. Lironi; and to carry on the manufacture and sale of electrical or magnetic movements or timepieces or electric machinery. Signatories (with 1 share each): J. J. Bowman, Electric Works, Arnold Road, Bow, E.; A. E. Lironi, Walnut Tree House, Leytonstone; W. H. Napier, The Hermitage, Penn, Bucks; H. Cock, 14, Union Court, E.C.; G. H. Potts, Chartreuse, Richmond, S.W.; G. F. Davenport, 54, London Wall, E.C.; W. Bryant, 36, Cambridge Street, S.W. The number of directors is not be less than three nor more than seven, the first to be appointed by the subscribers. Remuneration £500 per annum between them. Registered on the 26th ult. by W. Beck, 2, East India Avenue, E.C.

Kitto Cycle Company, Limited.—Capital £20,000, in £1 shares. Among its objects is included the following: To carry on business as electric engineers and manufacturers of and dealers in machinery and apparatus relating to the production of electric force and power in all their branches, to employ and utilise electric force and power in producing and utilising light, and to generate, accumulate, distribute and supply electricity for lighting places, both public and private. Signatories (with 10 shares each): G. F. Youlton, Springfield, Plymouth; W. H. Jennings, 58, Emma Place, Stonehouse, Plymouth; J. Willoughby, 3, Suffolk Terrace, Plymouth; W. H. Kitto, 197, Union Street, Plymouth; J. T. Bond, 5, Woodland Terrace, Plymouth; S. H. Duff, 23, Westnall Street, Plymouth; P. T. Pearce, 17, Lockyer Street, Plymouth. The first four signatories are the first directors. Registered office, 197, Union Street, Plymouth.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

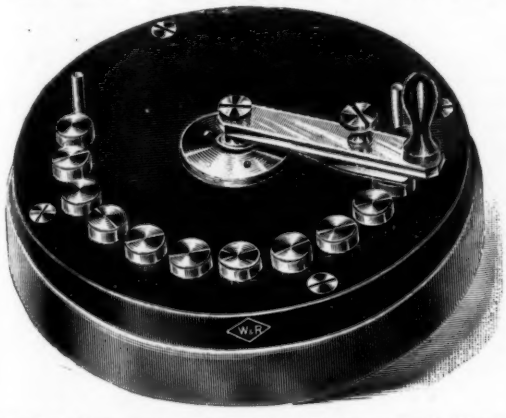
Electrical Inventions Company, Limited.—The first registered office of this company is situate at 57, Moorgate Street, E.C. (Filed 28th ult.)

Globe Electric Company, Limited.—The first registered office of the above-named company is situate at 36, Great James Street, Bedford Row, London, W.C. (Filed 28th ult.)

Crompton and Company, Limited.—The notices of an increase of £50,000, divided into 10,000 preference shares of £5 each, bringing their capital up to £190,000, were filed on November 17th, 1891.

BUSINESS NOTICES, &c.

Circular Resistance.—Messrs. Woodhouse & Rawson United, Limited, of 88, Queen Victoria Street, E.C., have just stocked switches of the type shown in the diagram. These may be had



either 12 or 20 way, and are mounted on slate bases neatly fitted into wooden frames. They are carefully designed, and no doubt will be much in demand.

The London and Lancashire Electric Company.—A very successful installation of electric lighting has been carried out on the business premises of Mr. Lipton, High Street, Kingsland. The installation consists of nine "Weston" arc lamps of 2,000 candle power each, and a "Weston" dynamo, driven by a semi-portable engine by Marshall, Sons & Co., Limited. The work has been carried out by the London and Lancashire Electric Company, of Kingsland Green, Dalston, London, who have a large stock of these dynamos and arc lamps ready for delivery, and various contracts for these goods in course of completion. The private residence of Dr. Walter Smith, the vice chairman of the St. Pancras Electricity Committee, has also just been fitted up with the electric light by this company; the current being supplied from the mains of the St. Pancras Vestry.

Moody and Andreae.—It is announced that Mr. W. Andreae having withdrawn from his partnership in the above firm, the name thereof will in future be Messrs. Moody Brothers. Messrs. Moody Brothers having taken over the stock and business premises of the late firm, will execute all orders now in hand, and will continue to carry on the business as heretofore. They also assume responsibility for all unexpired guarantees and outstanding estimates given by the late firm. Messrs. Moody Brothers are authorised to collect and give receipts for all money owing to the late firm; and it is requested that all cheques be made payable to their order. All goods now on order for Moody and Andreae are to be delivered to Moody Brothers; and they will settle all the outstanding debts and liabilities of the late firm.

The Mint, Birmingham, Limited.—We are informed that Messrs. Edward Le Bas & Co., 49, Lime Street, E.C., have been appointed agents for the above company's London, home, and export trade. Attention is drawn to their seamless copper tubes, manufactured under their new patent process, whereby the quality and finish is unsurpassed, while prices compare favourably with other manufacturers. Samples of these tubes can be seen at the agent's office. The firm also make a speciality of high-conductivity copper wire suitable for electric and telephone work.

London County Council.—The Clerk of the London County Council invites tenders for the electric lighting of the central offices of the Council in Spring Gardens and at No. 31, Spring Gardens. Drawings and specifications can be inspected on application at 42, Cranbourne Street, W.C., upon payment of the sum of £5 5s. (which will be returned on delivery of a bonâ-fide tender). Latest date for receipt of tenders 15th December.

Robey and Co.—This firm purpose exhibiting at the Smithfield Club Cattle Show, to be held at the Agricultural Hall, London, from December 7th to 11th, a number of engines of their latest designs and most approved construction, including combined engines and boilers, portables, horizontal fixed, "Robey" gas engine, &c. Inspection is invited. We have received copies of descriptive price lists from Messrs. Robey & Co. of their gas engines, also horizontal and high speed compound engines, and we think they will be very useful to the firm's customers and users generally.

Woodhouse & Rawson United, Limited.—We have received from this firm a copy of their List B. Section 8, illustrated catalogue of electrical machinery and apparatus connected therewith, including engines, dynamos, accumulators, lamps, switches, fittings, instruments, &c. The pamphlet also contains prices and illustrations of steam and electric cranes and lathes and other engineers' tools. On the whole we believe the information given will prove very useful to Messrs. Woodhouse & Rawson's numerous customers as well as to the electrical and engineering trade generally, whom we recommend to inspect the book.

Tenders Wanted.—Bournemouth.—The Clerk of the Bournemouth Town Council invites tenders for lighting by electricity their pier, pleasure gardens, and municipal buildings. Full particulars, forms of tender and plans can be obtained of the Borough Engineer and Surveyor, Mr. F. W. Lacey, Town Hall Chambers, Bournemouth, upon depositing the sum of £5 5s. with the Town Clerk, which is returnable if tender is not accepted.

J. H. Holmes & Co.—The Liverpool Dock Board have recently contracted with Messrs. J. H. Holmes & Co., of Newcastle, for the supply of an electric search light plant for use in connection with the dredging work which is at present being executed. The light will be carried by a tender, and is to be of sufficient power to render visible buoys, 10 feet diameter and 10 feet high, at a distance of one mile on a clear, dark night.

Tender Wanted for Lighting Galatz.—All persons willing to undertake the lighting by electricity or gas of the town of Galatz (Roumania), are informed that they may see or procure at the Mayoralty the plan of the town and the terms and conditions. Tenders may be sent in up to January 20th, 1892, when the adjudication will take place.

Simplex Arc Lamp Patent.—The Simplex arc lamp patent for the United Kingdom, which has nine years to run, is offered for sale, also patents for New Zealand and New South Wales, stock of lamps, globes, and various parts; all are for sale for cash cheap. For further particulars see advertisement in the ELECTRICAL REVIEW.

Tender Wanted, Worcester.—The Worcester Corporation are desirous of receiving tenders with plans and specifications for constructing works for the supply of electricity to the central portion of the City. Tenders to be delivered on or before the 14th February, 1892, to the town clerk, Guildhall, Worcester.

Tender for Telegraph Stores Wanted.—The North Eastern Railway Company invite tenders for telegraph apparatns and stores. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to the secretary at York, by noon on 8th inst.

Tender Wanted.—New Swindon.—The Swindon New Town Local Board invite tenders for supply of gas *or other illuminating power*, for all the lamps in the district of Swindon New Town for one year, commencing January 1st, 1892. Particulars on application to the clerk.

A Substitute for Leather and India-Rubber.—A new material known as "Blandyte," having the properties of leather, India-rubber, vulcanite, &c., is being introduced by the Blandyte Syndicate of 72, Gracechurch Street, E.C.

Whitehaven Tenders.—The time for sending in tenders for the Whitehaven Town and Harbour Trust Electric Lighting order has been extended to the 26th inst.

CITY NOTES.

St. James' and Pall Mall Electric Light Company, Limited.—The St. James' and Pall Mall Electric Light Company are issuing 10,000 7 per cent. preference shares of £5 each at £1 10s. premium (being the unissued balance of the 20,000 preference shares created March 20th, 1891.) These new shares will carry no interest or dividend for the year ending December 31st, 1891, but from January 1st, 1892.

Brazilian Submarine Telegraph, Company, Limited.—The directors of this company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30th last, and payable on the 21st inst.

TRAFFIC RECEIPTS.

The City and South London Railway Company. Traffic receipts for the week ending November 28th, amounted to £806.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of November were £3,200 as compared with £3,193 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of November, 1891, are £2,235, as against £2,722 in the corresponding period of last year.

The Eastern Extension, Australasia, and China Telegraph Company, Limited. The traffic receipts for the month of November amounted to £40,686, as against £44,742 in the corresponding period of 1890, showing a decrease of £4,056.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of November were £60,053, as against £58,975 for the same period of 1890, an increase of £1,078.

The West India and Panama Telegraph Company. The receipts of the West India and Panama Telegraph Company for the two weeks ended November 30th, show a decrease of £532 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Nov. 26th.)	Closing Quotation. (Dec. 3rd.)	Business done during week ending (Dec. 3rd, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	49 — 50	49½	49
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	86½— 87½	87 — 88	87⅝	87
2,849,510*l*	Do. do. Deferred	Stock	12 — 12⅛	12 — 12⅛	12⅛	...
130,000*l*	Brazilian Submarine Telegraph, Limited	10	10¾— 11	11 — 11⅛	11 5/16	10⅞
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅜— 3⅝	3 — 3¼	3⅜	3⅛
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2¼— 2⅜	2 — 2¼	2¼	2
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	3¼	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	...	3¾— 4¼	4½— 5½	5¼	4
$7,716,000	Commercial Cable, Capital Stock	$100	140 —145	145 —148	147½	146
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	7/16— 9/16	3/8— 1/2	7/16	...
20,000*l*	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5¼— 5⅝	5 7/16	5⅜
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000*l*	Do. do. 10 p. c. Preference	10	16 — 17	16 — 17	...	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3 — 3½	3½ — 3¾	...	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10¾— 11	10¾— 11	11	10⅞
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14¼	14 — 14¼	14¼	14 1/16
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14⅝— 15½	15¼	14⅞
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	107½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	15 — 15¼	15 3/16	15
78,300*l*	{ Do. 5 p. c. (Aus. Gov Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110	107 —110	110	107½
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	98 —101	98 —101	98½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6½— 7	6½— 7	7	6⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2 — 2¼	2 — 2¼	2½	2 1/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2¼— 3⅛	3¼— 3½	3 7/16	3 3/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd	2	1⅝— 1⅞	2¼— 2⅝	2 5/16	1⅞
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 9⅞	9 13/16	9⅝
180,042	Do. do. 6 p. c. Preference	10	14⅜— 14⅝	14⅜— 15	14⅝	14 11/16
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18½— 19½	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	20½— 21½	20½— 21½	21	20½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	6 — 7	5 — 6	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8¾— 9¼	8¾— 9¼	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	10 — 10½	9¾— 10¼	10⅜	9⅞
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4 9/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 13	12 — 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	107 —109	108¾	108
250,000*l*	Do. (issued at 5 p.m., all paid)	...	28 — 32	28 — 32	...	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	6 — 7	6 — 7	6⅞	6½
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000*l*	Reuter's Limited	8	7½— 8½	7½— 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¾— 9¼	8¾— 9¼	9 1/16	8¾
7,900	Do. do. do. 7 per cent. pref.	2	7¼— 7⅝	7 — 7½	7½	7¼
3,381	Submarine Cables Trust	Cert.	117 —122	117 —122	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4 — 4½xd	4 9/16	4¼
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43	42¾
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7½— 8½	7½— 8½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures, ...	100	96 — 99	97 —100	98½	98
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	3⅝	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —102	97 — 102	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10 — 10½	10 —10½xd	10⅜	9⅞
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 6⅝xd	6⅝	6⅜
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	3¾— 4¼	3¾— 4¼	4¼	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅜— 1⅝	1½— 1⅝xd	1 11/16	1 9/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9 — 9½	9 — 9¼xd	9⅜	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	7½— 8½	7½— 8¼xd	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6½— 6⅝	6½— 6⅝	6⅝	6⅜

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—Electric and General Investment, Shares of £5, £1 paid, 2⅜—3½.—European Sims-Edison Torpedo Company, shares of £20, fully paid, 20—20½.—Halifax and Bermuda Cable, 4½ per cent. bonds, 85—95.—House to House Company (£5 paid) 4½—5.—*Liverpool Electric Supply, Shares of £5, £3 paid, 2⅜—2⅝. Shares of £5 (fully paid), 4⅞—5⅛.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅜—1⅝. Do. 6 per cent. Preference, 1⅞—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid), ½—⅝.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—£5 Preference, fully paid 3⅜—3⅝.—Wards Electric Car, £10 paid, ¾—1.

* Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—4 per cent. (October 29th, 1891).

THE DYNAMOS AT FRANKFORT EXHIBITION.

BY W. B. ESSON.

VIII.

MESSRS. W. LAHMEYER AND COMPANY, of Frankfort, had a most interesting exhibit, which comprised machines both for lighting and transmission of power. The largest machine shown was a 4-pole, giving 80 kilowatts, and is illustrated in fig. 38. At a speed of 350 revolutions per minute the pressure is 660 volts, while the working current is 120 amperes. The armature is drum-wound, and the core has a diameter of

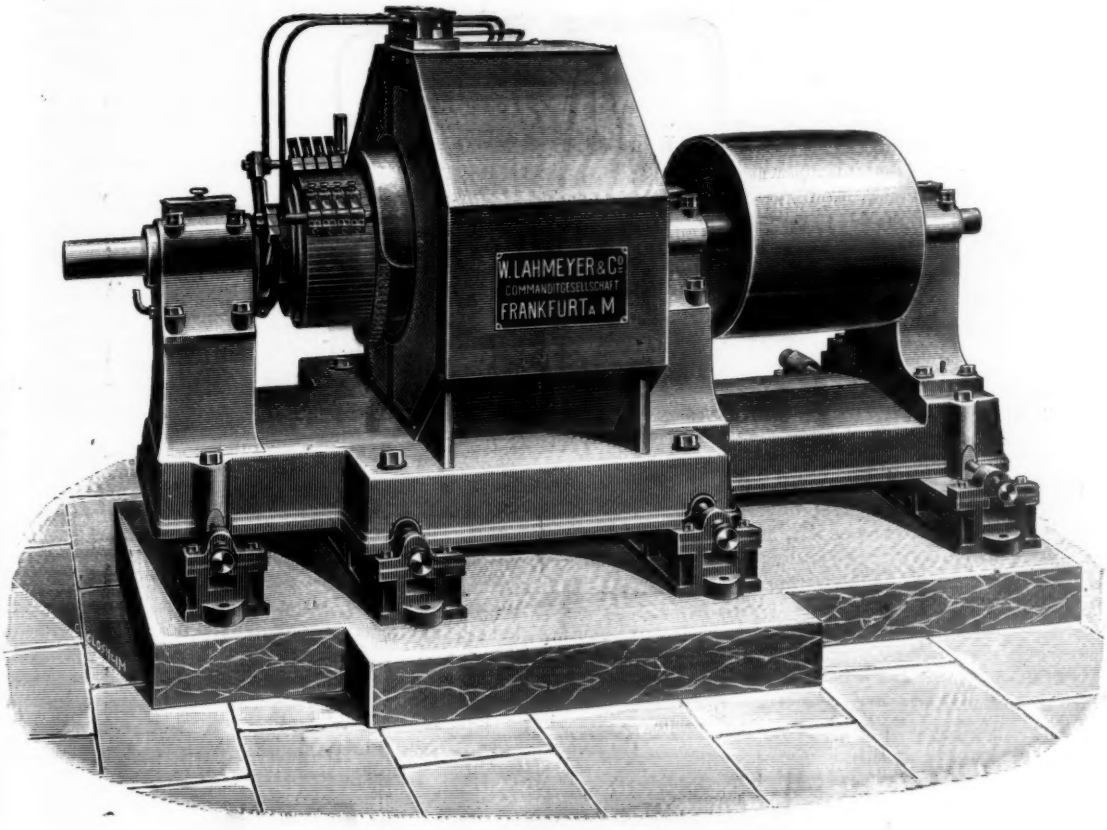


FIG. 38.

60 cm. and a length of 44 cm. It is built up of about 500 iron plates separated from each other by paper, its general construction being shown by the sketch, fig. 39. The central bush having four projections is of cast iron, a steel key

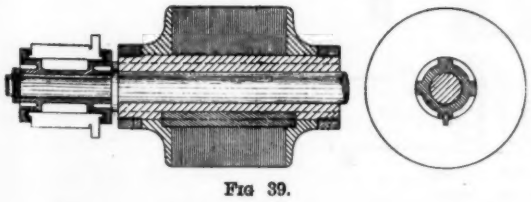


FIG 39.

going half into one of the projections and half into the plates, serving to drive the core positively, while the bush itself is secured to the steel shaft by a feather not shown on the sketch. The brass end plates are tightened against the core plates by wrought iron nuts screwed on to the bush. The commutator is carried by a cast iron centre piece furnished with wrought iron nut and rings for tightening up the copper segments. The latter, of which there are 111, are insulated from each other by mica, while the rings between the segments and the nuts are of "presspahn." The armature has 111 slots on its exterior, and it is wound with 111 coils, each having three turns of wire 4·5 mm. diameter. There are consequently 666 conductors on the armature counted all round, 6 in each slot. The resistance of the winding is ·185 ohm, and the weight of wire is about 101 kilogrammes. Two sets of four brushes, 45° angular distance apart, collect the current which flows through the armature in two parallels.

The field magnet is of cast iron, both yoke ring and cores being cast in one piece with the bedplate, as shown in fig. 40. Each of the magnet coils has wound on it 840 turns of 3·6 mm. diameter wire, the total weight on the four being 576 kilogrammes and the resistance 9·36 ohms. The magnets are excited by a separate upright 2-pole drum machine made by Pokorny and Wittekind, of Bockenheim, whose exhibit was described last week. Power is supplied by a compound horizontal engine running at 70 revolutions per minute, and having cylinders 38 cm. and 57 cm. diameter, with a

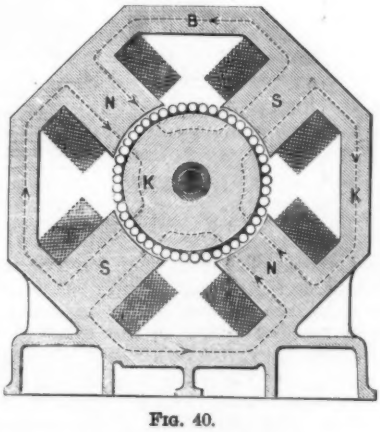


FIG. 40.

stroke of 70 cm. The dynamo, it will be noticed, rests on four bedding rails, provided with belt tightening screws, while the armature is supported by three long bearings, each lubricated by rings dipping into an oil well in the standard.

A smaller 4-pole machine, giving 60 kilowatts at 550 revolutions per minute, was also shown. This was of the same type as the one described above, which, in fact, represents generally the construction of all the dynamos, motors and motor-dynamos made by this firm. To the last named appliance Messrs. Lahmeyer have given a good deal of attention, and the modifications they have introduced are well worth description. The motor-dynamos hitherto described have been literally two machines coupled together, one taking power as a motor, and the other giving power as a dynamo, both armatures running, of course, in separate fields. These have been constructed by Deprez, Siemens and Halske, Schuckert and others. The method of constructing motor-dynamos by winding two distinct circuits on one armature, coupling up to two commutators, and running in a common field, has been used by several in this country; but the writer is not aware that Lahmeyer's method of compounding a machine of this type has yet been tried. If, in a motor-dynamo of the kind, having two windings on the armature, the motor end is supplied with current at constant pressure, the difference of potential at the dynamo end will fall as the load increases, in consequence of the armature windings having a certain amount of resistance. The E.M.F. of the motor is diminished because a certain pressure is expended in sending the current through its armature, and this, of course, diminishes the E.M.F. of the dynamo, while the pressure required to send the current through its armature reduces in turn the difference of potential at its terminals available for lighting. A certain loss of pressure is therefore unavoidable under ordinary circumstances. It may be very small, only from 1 to 2 per cent., but though not much it is in the wrong direction, since a rise of pressure is wanted rather than a fall as the load increases. When the dynamos or accumulators from which the power is derived are close to the motor-dynamo, the tendency for the potential difference to drop at the secondary may be counteracted in various ways, and no inconvenience may result; but when the power is derived from a distance, as, for instance, in the transmission from Offenbach to Frankfort, such regulation becomes difficult, and it is to meet cases of this kind that Messrs. Lahmeyer have introduced compound winding.

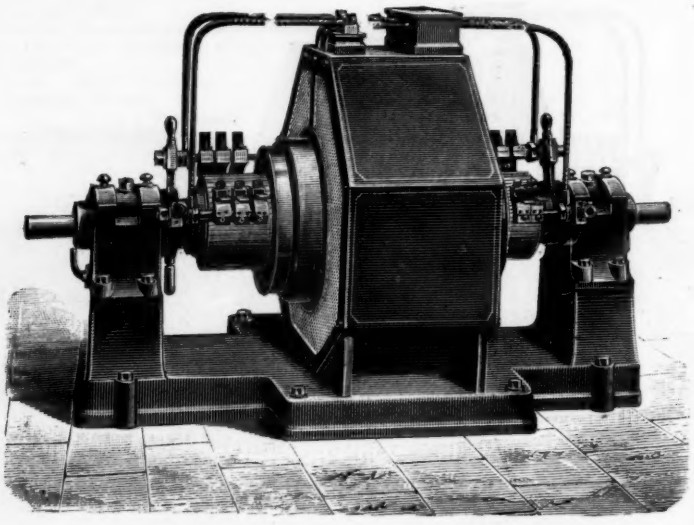


FIG. 41.

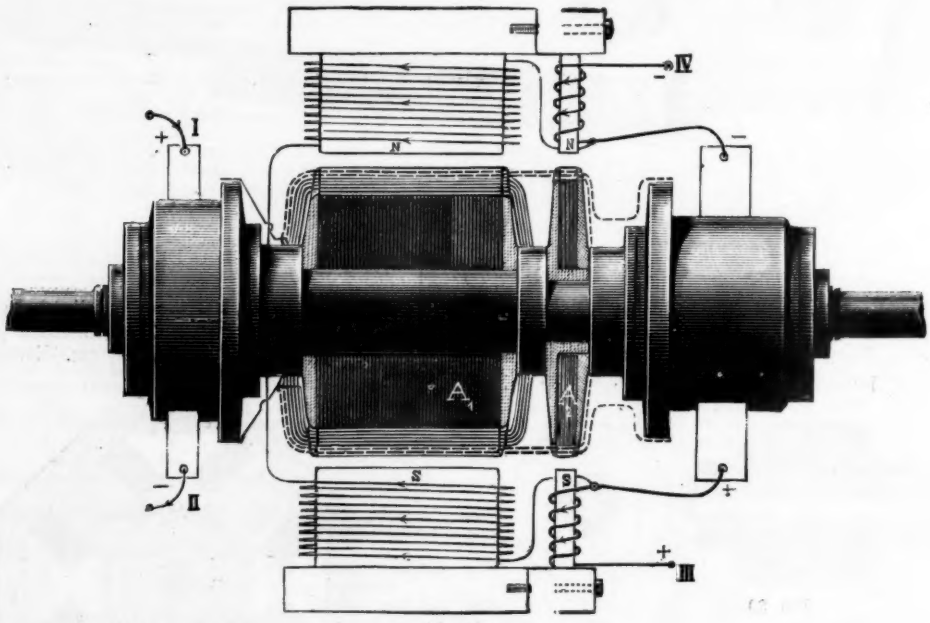


FIG. 42.

A general view of Lahmeyer's ordinary motor dynamo without compound winding is shown in fig. 41, while a diagram illustrating the principle of the "far-distance" compounding is given in fig. 42. The difference of potential being maintained constant at the terminals of a distant dynamo, the current at high pressure enters the brushes, I. and II., on the left hand, the low-pressure current for lighting being derived from the ter-

minals to the right, marked III. and IV. On the drum armature, A_1, are two windings for high and low pressure, lying one above the other in slots, with the low pressure on the top. But while the fine wire or motor winding is confined to the armature, A_1, the secondary winding is brought over an auxiliary armature, A_2, the wires lying in slots in its circumference, as shown. This winding is subject to the influence of an auxiliary set of magnets, excited by the low-pressure current, and there is consequently added to the secondary circuit an E.M.F. proportional to the current flowing. This makes up for the loss in the armature windings, and in the wires leading from the distant dynamo, keeping the pressure constant at the terminals III. and IV., or, if required, raising it by the amount necessary to compensate the resistance loss in the lighting mains. It must be recollected that no alteration of the strength of field, as a whole, would effect the end in view; compounding the field of both A_1 and A_2, for instance, would only make the machine run at a slower speed. The pressure at the secondary can be kept constant only by raising the pressure at I. and II., which under the conditions discussed is not permissible, or by altering as the load increases the relation between the fields of the motor part and dynamo part, which Lahmeyer does by his auxiliary magnets excited by the secondary current.

It will be observed that both the principal field and the auxiliary field are excited from the low pressure end of the machine; but as this is not available for starting, it is necessary to wind on the main field underneath the fine wire a few convolutions of wire in series with the line. On commencing to run the machine these are in the circuit, and fig. 43 gives a diagram of the switch arrangements used in con-

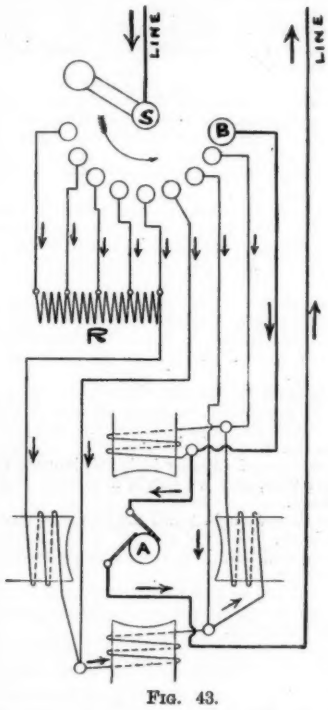


FIG. 43.

junction with them, the connections of which can be readily traced. S is the switch which in starting must be moved in the direction of the arrow, R is a resistance which is in circuit at starting, but is gradually removed, A is the high pressure commutator. It will be seen that at first the convolutions on all four magnet limbs are in series with the line and with R. As the speed rises the switch lever is moved from block to block, gradually taking the resistance out, and finally cutting out the magnetising coils one at a time, until when on the last block, B, the line is direct on to the primary brushes.

The "far-distance" motor-dynamo, described in preceding paragraphs, may be looked upon as an ordinary motor-dynamo with a small series dynamo in the secondary circuit, and it gives the same result as would be obtained by coupling a compound dynamo to a shunt motor. Now, a constant difference of potential at the secondary terminals may be obtained, as previously stated, by adding an E.M.F. to the primary instead of to the secondary circuit as the load increases. If, then, a small series dynamo is placed in the line in series with the principal generator we may dispense with the compound winding on the motor-dynamo, and still have the pressure constant at the secondary terminals, the losses being made up by an E.M.F. added on the primary side of the machine. Messrs. Lahmeyer employ both methods for transmission, and for the Offenbach-Frankfort experiment arrangements were made so that either could be tried. The dynamo at Offenbach gave a current at 2,000 volts, and had its magnets excited from the mains of a lighting installation at that place. The line wires were for the first experiment connected to a compounded motor-dynamo 10 kilometres distant at Frankfort, and the current given by this latter machine at 110 volts pressure was utilised for lighting. The second experiment consisted in connecting the leading wires to an ordinary motor-dynamo without compounding, a small series dynamo giving 200 volts at full current, being this time included in the circuit and placed beside the principal generator. In both cases the pressure at the secondary terminals was practically constant.

The full current transmitted from Offenbach to Frankfort was 25 ampères, and the power therefore about 67 H.P. The sending dynamo was of the 4-pole drum type, as already described, with the conductors laid in slots on the exterior of the armature core. To send the current through the line wires 200 volts were required, the loss being therefore, at full load, about 10 per cent. The experiment of transmission to a triple phase, synchronising "drehstrom," motor-dynamo was also made, the 2,000-volt commutators being then displaced by three rings in generator and motor, and a third line wire added. It will be remembered that a motor-dynamo of somewhat similar kind was referred to in our description of Schuckert's exhibit, but as the subject of multiphase currents is receiving admirable treatment in another series of papers, the present writer merely records here the fact of the experiment having been made.

(To be continued.)

HOW TO GET PAYING LOADS FOR STATIONS.*

BY PROF. W. D. MARKS.

(Read at the Seventh Annual Convention of the Association of Edison Illuminating Companies, New York City, August 12th, 1891.)

WHEN the constructing engineer, who may be called the organ builder, has completed the station, he will, if he is fond of his own ease and can afford it, give way to the general manager or engineer, who stands toward him in the relation of the organ grinder.

The manager, if he has not had previous experience, soon finds that he must combine with his knowledge as an engineer the energy of a locomotive, the activity of the Devil, the sleepless vigilance of Cerberus, and the manners of a courtier. In days of prosperity and smooth running his board of directors will gladly share with him the credit and glory of success; in fact, very few will hear of him at all; but let anything go wrong, let a breakdown occur, or the enterprise not prove profitable, there is but one man to blame—the general manager. It is proper to say right here that this opinion is the result of observation and not of personal experience. The writer desires to express his grateful appreciation of the uniform courtesy and assistance he has received from his own board of directors, who have patiently waited for two and a half years for a dividend now fairly in sight for the first time. But this is, unfortunately, not generally the case.

Those of you who are familiar with the history of central stations know how frequently your kindly enquiries after the manager of early days is answered by "He is dead," "He is in the insane asylum," or "I don't know where he is; he couldn't make the station pay, and resigned." These few words form the epitaph of many an able manager who has bravely struggled on against overwhelming difficulties and become discouraged, to be succeeded by another and perhaps another, until the public, becoming acquainted with the light and sure of its permanency, have taken it in sufficient quantity to pay the running expenses of the station, after which the progress and profits rapidly increase. The fortunate manager who came in at that period of the company's history had but to look sharply after the machinery, give a thoroughly good light and make prompt collections, to give great satisfaction to a body of stockholders who had invested their money for the purpose of obtaining dividends, and as one of ours told me, "are in this business for money."

The question, "How are we to reach this happy condition of affairs in the briefest space of time?" is proposed for discussion. I know

* New York *Electrical Review*.

that many of my hearers are doubtless quite as well able to discuss it as I am, but they may not have had quite the same conditions to deal with, and I may, therefore, hope to interest them in my different experiences and expedients.

First of all, the story of the Philadelphia station is not a mere theory. We have a good paying load of 64,000 sixteens and only half the machinery in. The station is designed to carry 80,000 lights burning at once, and we can, when the station is completed, wire 150,000 lights and carry them, basing our estimate on Philadelphia's average burning in the past.

The price of gas is $1.50 per thousand, which is the same as three-quarters of a cent. per 16 candle-lamp hour. We fixed the price at one and one-eighth cents. per lamp-hour at the start, and we ran from March 5th to October 1st, 1889, with rather poor success in obtaining lighting. The price was the same as gas at $2.25 per thousand. We had to acknowledge that electricity cost more than gas, and that it was a luxury. After a few months we fixed the price at three-quarters of a cent per lamp-hour, and directed our agents to say that our light cost just the same as gas and was vastly better and more healthful.

This change was brought about by Mr. Edison's influence. I had had several conversations with him, and he always advocated meeting the price of gas squarely. I finally laid his views before our board of directors, and they adopted the price named by him. There was an immediate change. The simple statement, "It costs no more than gas," brought many consumers to us who had heretofore refused to consider the matter of using electricity. We do no free house wiring, but we at first furnished service, meter and lamps free of charge. We did this till October 15th, 1890; after that we furnished only a meter free, and the consumer paid for service and the first installation of lamps. We still renew lamps free of charge when not broken. We prefer not to do house wiring or to sell any particular make of motor. We got out elaborate rules and tables for house wiring, and established an inspection department, and insisted on the rules being obeyed to the letter. We urged upon the gas fixture men of Philadelphia the establishment of wiring departments, and we wrote to all motor firms we heard of, asking them to appoint agents in Philadelphia.

This has resulted in the establishment of 13 wiring firms and the appointment of agents for 19 motors of different types. We had thus obtained 32 canvassing agents, who made a profit if they secured customers for us, but who did not get salaries from the Philadelphia company.

We paid 15 cents premium for all lights secured, and $1.50 per horse-power on all motors when the current was turned on.

Each one of our 32 free-lance agents had his own circle of acquaintance and lines of influence.

No injustice is done in saying that new things meet with twice the opposition in Philadelphia than they find elsewhere. But this body of canvassers was invincible. If we heard, or thought we heard, of a man who wanted light or power, we sent a card to each of the 32 firms, and before night that man had surrendered or left town. Very few escaped us. We had tin flags painted red and put on the end of a pointed iron bar, and on these was painted, "The Edison Electric Light Company. Apply for services at 909, Sanson Street." At night we guarded our ditches by hanging lanterns on hooks on these flags, and in the daytime we left them standing without the lanterns. We advertised every ditch and line of conductors this way. We did not advertise steadily in the newspapers, but we distributed throughout our districts thousands of circulars, giving all the information that an intending customer could possibly want.

We had but one salaried agent as solicitor; he also received a commission on lamps and motors, and earned, I think, three or four thousands in addition to his salary in one year.

Every form of advertising and solicitation paid, and paid well, but the best advertisement of all is a satisfied customer. Give a customer an honest 16 or 17 candles all the time but no more, charge him the fixed rate and stand by the meter record. The meters have proved practically correct; if they err at all, it is against the company, because of overloading. Our meter plates are always weighed in succession by two independent weighers, this work keeping them busy all the time for 1,100 consumers.

All of the staff of *employés* are instructed to be uniformly polite and reticent, no matter how unreasonable the consumer may be. If a bill is disputed, we test out the wiring for grounds or crosses and go over all of our meter calculations again. If there still appears the slightest ground for just complaint, an inspector is detailed to keep a lamp-hour record by actual count. We never have found our meters to overcharge the consumers.

If a complaint is made of a motor bill, we pursue a similar course, and also, by means of an ampèremeter, test the current. We frequently find motors loaded to twice their rated capacity. If we are satisfied that we are correct, we notify the consumer that 15 days after date of bill he will be cut off, and do it, and sue him for the bill. If a customer does not pay his bill in 15 days, the chances of his doing it at all are very slight, and it's no use talking to him after a bill gets old.

Our general agent visits in person many of our consumers who have by misconception felt themselves aggrieved, and we find that a pleasant discussion and explanation of the matter in dispute almost invariably ends in a clear and cordial understanding with our customer.

We try to be unfailingly just with our consumers, regardless of consequences to ourselves, and we feel now that they believe in us.

We sell power to all 110-volt motors at lamp rates. For 220 volt-motors our rate is 7½ cents per horse-power hour. If a consumer takes more than 1,000 horse-power hours and less than 1,500, we fix the price at $75 for four weeks.

All power above 1,500 is sold at 5 cents per horse-power hour.

CONTRACTS *v.* METERS.

The question at once arises in the minds of many of my colleagues, "Why not sell light, or at least power, by contract, instead of meters?"

The answer is, because in the long run it is less profitable, and overloads the station too quickly.

You will recall how our energetic band of 32 canvassers was secured by taking advantage of their desire to make money.

The underlying law of all business is selfish money getting or saving.

Without being deliberately and intentionally dishonest, nine consumers out of ten will fail to keep within the limitations of a contract for light or power; they will forget to turn out lights and to stop motors unless they are reminded of any oversight of this sort by the regular presentation of their meter bills. Making contract consumers pay for lamps does not seem to check them, they simply growl about the short life and price of the lamp; besides, these frequent small charges for lamps serve as a constant irritant to consumers, and provoke much criticism of the lamps. Still the meter alone, without any contract, has its disadvantages.

When we were furnishing lamps free of charge, a gentleman on Rittenhouse Square put 400 lights into his dwelling, and paid us by meter bills $800, the first year $2 per lamp per year only, and we had furnished free service, free meter, and free lamps; certainly not a profitable investment. So we now make all consumers guarantee us 6 cents per lamp per week, and only put in a free meter and cut-out, and renew lamps free. If the lamps are burned on an average more than 6 cents worth a week, a meter bill is rendered. This insures a minimum earning power for each lamp of $3.13 per year, and does not frighten consumers away.

It would appear from our experience as though light consumers were profitable in the following order, although no rigid classification is possible.

Restaurants, gambling houses, &c., clubs for social purposes, hotels, newspaper and telegraph offices, theatres and opera houses, small factories and business houses, stores for sale of dry goods, &c., buildings used for offices, dwelling houses, Protestant churches.

The latter being open only on Sunday and a few evenings in the week, and on these for a few hours, should never be lit without a contract insuring the earning power of the lamps. The only advantage that can be claimed by churches is, that they burn light when almost everyone else does not do so.

At the start we heard a great deal of special inducements to be offered to consumers who use light and power "out of hours"—that is, before 5 and after 11 p.m., and on Sundays.

With the exception of printing offices and churches, there are very few of these consumers.

It is certainly advantageous to get them, but they do not exist in large numbers. Motors which run during the day, say, from 7 a.m. to 6 p.m., are advantageous, as giving the machinery of the station a uniform load; but in winter, when the lighting begins at 4.30 p.m., they overlap the lighting load, making a maximum load occurring between 5 and 6 p.m., and sometimes a very high maximum as compared with the average load.

Small factories, business houses, stores and buildings used for offices closing at 6 p.m., all add largely to this maximum load, without burning on an average more than one and a half hours in 24, and for this reason should not form too large a proportion of the station load.

We have endeavoured in every way to increase the sales of our current, and for this reason we have sold all supplies required by wiremen at 8 per cent. advance on their net price as billed to us, thus reducing the cost of wiring. We believe results to have shown this to be a proper policy.

We have endeavoured, by concentrating all our machinery into a single station of large capacity, to obtain great economy of running expenses, and to enable the employment of the best possible men in each special department.

All and every expense of running included, it costs us from $2.50 to $3 per lamp per year, and we obtain a revenue of about $5 per year from each lamp.

A subject of anxious thought to all managers is how to increase this revenue per lamp.

By getting lamps that burn long hours is the answer, or by getting motors for day service.

But motors do not pay as high rate for current as lamps, and people who burn light long hours, will put in an isolated plant if they have more than a very few lamps.

I cannot give my own views better than to repeat to you my letter of February 17th, 1891, addressed to our board of directors.

"Philadelphia, *February 17th*, 1891.

"*To the President and the Board of Directors of the Edison Electric Light Company of Philadelphia.*

"Gentlemen,—Touching the matter of the cost and the selling price of electric light and power, it seems to your engineer and manager that, with the near approach of the limit of our present machinery and building capacity, he should lay before you his views in detail as to the proper method of dealing with our consumers, which, while equitable to all, he hopes will result in increased daily profit to the company.

"At present, on an average, all our lights and motors are profitable to us, costing us about $\frac{35}{100}$th of a cent, and being sold at from ½ of a cent to ¾ of a cent. per lamp hour. Had we storage capacity for electricity, as has a gas works, we would be able to continue all and increase indefinitely until the full capacity of our feeders, 50,000 lamps burning at once, or say 100,000 lights wired, had been reached. As it is, we must stop when we reach 14,000 ampères, or about 30,800 16 candle-power lamps burning at once. This would appear to be the case when we have 67,500 lamps wired.

"While all of our lamps are profitable to us, as stated above, still, there being a limit to the number attached, there must be a sufficient

margin of profit, on the average, to enable us to meet the demands for dividends, interest on and sinking fund for debenture bonds. We can neglect our floating indebtedness, as I am advised that there are enough quick assets to cover this.

"Thus we have to meet the following demands the first year:—

Sinking fund to retire debentures	$37,500
5 per cent. premium on the same	1,875
Interest on $300,000 at 6 per cent.	18,000
Dividend, 6 per cent. on $1,000,000 stock ...	60,000
	$117,375
Amount cash surplus required each month ...	$9,781.25
The cash surplus for January is	12,766.69

"Thus you will see that this company is already on a dividend earning basis.

"As the sale of merchandise and isolated plants forms but a small part of the duties of those *employés* having the care of it, and will not increase, we can neglect it as not forming a separate and important item.

"We have connected 55,064 16-candle-power lamps, and our gross income is $28,507.09, yielding us $51\frac{4}{10}$ cents per lamp per month, or $1\frac{71}{100}$ cents per lamp per day, the average burning of each lamp being $2\frac{56}{100}$ hours.

"This gives us an average selling price of $\frac{668}{1000}$ths of a cent. per lamp hour.

"Then for each 16 candle-power lamp we have—

Average income	$1\frac{71}{100}$ cents per day
" cost $2\frac{56}{100}$ hours at $\frac{346}{1000}$ cent ...	$\frac{80}{100}$ " "
" profit per lamp...	$\frac{82}{100}$ " "

"Thus we see that we have reached a moderate dividend earning basis, with an average profit of $\frac{82}{100}$ths of a cent. per lamp per day, but the risk of the business and the long delay in obtaining any return for capital invested should make us give careful thought to any scheme which promises to enable us to obtain larger dividends.

"Each director has offered to him an elaborate analysis of the record of each consumer, and those that are interested can judge for themselves of their value.

"Assuming now that it is decided not to continue lights yielding less than $\frac{82}{100}$ths of a cent profit per day, and thereby to raise the average above the present, we can construct the following table of prices, yielding the same profit each day:—

Selling at per lamp hour.	Profit per hour.	Hours burning required.	Discount from $\frac{3}{4}$c. per cent.	Remarks.
$\frac{40}{100}$c.	$\frac{5}{100}$c.	16 to 24	47	The hours are given only with sufficient approximation for business purposes.
$\frac{45}{100}$	$\frac{10}{100}$	8 to 16	40	
$\frac{50}{100}$	$\frac{15}{100}$	5 to 8	$33\frac{1}{3}$	
$\frac{55}{100}$	$\frac{20}{100}$	4 to 5	27	
$\frac{60}{100}$	$\frac{25}{100}$	3 to 4	20	
$\frac{65}{100}$	$\frac{30}{100}$	$2\frac{2}{3}$ to 3	13	
$\frac{70}{100}$	$\frac{35}{100}$	$2\frac{1}{3}$ to $2\frac{2}{3}$	6	
$\frac{75}{100}$	$\frac{40}{100}$	2 to $2\frac{1}{3}$	P'm. on $\frac{3}{4}$c.	
$\frac{80}{100}$	$\frac{45}{100}$	$1\frac{13}{14}$ to 2	7	
$\frac{85}{100}$	$\frac{50}{100}$	$1\frac{64}{100}$ to $1\frac{13}{14}$	13	
$\frac{90}{100}$	$\frac{55}{100}$	$1\frac{1}{2}$ to $1\frac{64}{100}$	20	
$\frac{95}{100}$	$\frac{60}{100}$	$1\frac{36}{100}$ to $1\frac{1}{2}$	27	
1 cent.	$\frac{65}{100}$	$1\frac{1}{4}$ to $1\frac{36}{100}$	$33\frac{1}{3}$	

"The cost of lamps is about one-seventh the running expense of the station, and, therefore, the cost of a horse-power hour is four and one-half cents. You are aware that we sell at seven and one-half cents, save in cases where a consumer uses more than 1,000 horse-power hours in four weeks, in which case he gets his power at five cents. per horse-power hour for the same reason and upon the principles which I have set forth in the case of lamps.

"Careful consideration of the table will convince you that there are cases of burning long hours in which apparently great concessions in price will result profitably to this company, and, on the other hand, that there are consumers burning short hours who should be charged a higher price than three-quarters of a cent., or not be taken at all.

"For instance, the Bullitt building should be charged one cent. per lamp-hour to bring it to the average.

"The Aldine Hotel averaged a return of $\frac{55}{100}$th of a cent the first year, but this year has been using the light extravagantly. Its contract should be terminated next September, and no contracts taken based on the former gas bills in any instance.

"Besides the greater profit of long hours, there are many advantages to the machinery, apparent only to the engineer, which he will not state here.

"Since the special order of this board, of something more than a year ago, directing your engineer and manager to make all contracts for light and power, he has been guided by the principles set forth above, but now feeling that perhaps you would prefer to have others to undertake this work, he is impelled by his interest in the welfare of this company to enunciate them in writing, and to beg your careful consideration of them before taking such action as might diminish the profits of this company.

"Very respectfully and truly yours,

"(Signed) WM. D. MARKS,

"*Supervising Engineer and General Manager.*"

It is proper to add that we have not a dozen cases in our 1,100 consumers in which any concession is made, and that we are actively engaged in getting rid of them, as full rate consumers offer themselves.

We have had elaborate analyses of the value of each consumer made, and know exactly what he is worth to us.

It does not properly come within our province in this paper to discuss economy of production, but I will state what are the principles upon which the erection of the Philadelphia station was based.

Concentration of power, economy of running expenses, simplicity of design, certainty and regularity of action of machinery.

We use Armington and Sims's single cylinder engines, making 220 revolutions and developing 440 horse-power at 150 lbs. of steam, one-quarter cut off.

They have performed very satisfactorily, doing all that was promised for them.

Our dynamos are No. 60 Edison type, making 400 revolutions and developing 1,000 ampères each. They have performed to our entire satisfaction, giving us great comfort since replacing iron bearings by phosphor-bronze. They will pull a station through almost any short circuit that can occur.

Our underground system remains practically perfect wherever we have used the Kruesi tube or the Edison system. Cables, whether lead-covered or not, have given us great trouble and expense where we have been forced by the city authorities to pull them into wooden conduits.

It is far better to bury a cable in the ground than to put it into a street conduit which is not hermetically sealed.

Our services are three-wire lead-covered cables buried in the ground, and of the many hundreds now in I cannot recall a single instance of trouble from them.

To resume, in brief, I would say:—

Put the price of light and power as low as you can, and thereby secure the permanency of your business as against competition.

Do no free house-wiring, but get others to do your wiring and make it profitable to them by offering premiums, if necessary.

Put no free lamps in first installation but renew them free of charge.

Own your own meter and service. It is not good policy to let the consumer own the service.

Do not try to sell any particular make of motor, and be careful not to express any preference. Offer premiums to agents.

Sell current by meter, but have a minimum contract price to ensure earning power of lamps and motors.

Above all things, always give a good light, but not an excessive amount of it.

Don't talk with or write to consumers in a threatening way who don't pay promptly.

Stand by the meter and cut off the light.

Be open and courteous in acknowledgment of errors and repair any injury unwittingly inflicted, regardless of consequences to yourself or the company. Don't believe the statements of consumers until fully verified.

At the end of the second year from the start we find our Philadelphia Company on a solid dividend-paying basis.

In any other enterprise of equal magnitude this would be called a great success.

ELECTRIC LIGHTING IN THE CITY.

ON Tuesday last a meeting of the City Commission of Sewers was held at the Guildhall to consider the application of the City of London Electric Lighting Company for an extension of time of at least one year for carrying out the public lighting of the City. Mr. Sheppard Scott presided. The letter of the company pointed out that they had taken over the contracts between the Commission and the Brush and Laing Companies for the lighting of the City. When the company was formed in July the other companies had not done more than make preliminary arrangements for provisional lighting to demonstrate to the Commission the nature of the work that it was proposed to undertake. When they took over the contracts in August only six months of the obligatory time specified in them were unexpired, and nearly everything remained to be considered and done in preparation for the large expenditure of capital which the great engineering work of supplying electricity to the City naturally required. The company had called in the best advice so that the proposals of their technical advisers should be fully confirmed, and so that no part of their works, which might eventually entail an expenditure of nearly a million sterling, should be put in hand without the exercise of careful foresight. Pending the results of the investigations the company had expended large sums on freehold and leasehold sites for generating stations, on generating plant and conduits, on the public lighting of Queen Victoria Street, and other ways. The company assured the Commission that no time had been lost or would be lost, and that every exertion would be made to supply the public and private lighting of the City by degrees.

Mr. J. L. SAYER moved that the letter be referred to the Streets Committee for consideration.

Mr. TRELOAR thought that the application was a preposterous one, and the Commission would be the laughing-stock of the community if they acceded to the request. It was quite time they knew where they were with regard to the matter.

Mr. MORTON, M.P., considered that the delay had all arisen from the company promoting to which the contracts had given rise. No sooner were the contracts signed than they were handed over to another company, who in their turn had passed them on to the present company after making an enormous profit for themselves. If the company did not complete their contracts the Commission ought to declare the deposit of £3,000 forfeited and should annul the contracts.

Mr. C. T. HARRIS reminded the Commission that he warned them at the time the contracts were entered into that the original companies were not in a position to carry them out, and it would be a fortunate thing for the ratepayers if the opportunity arose to annul the contracts, which were distinctly to their disadvantage.

Mr. J. E. SLY thought the company ought to be told that no extension of time would be given them, and that the Commission would not assist them in any object they might have of raising more capital.

Mr. STANLEY pointed out that the annulling of the contracts would mean, among other things, the abandonment of the electric lighting of the Mansion House, which he deprecated.

Mr. DEPUTY BEDFORD said the contracts had been transferred once or twice since they were given out, and the present company had paid an extravagant price for them. Owing to the delay which had arisen it was simply impossible for the contracts to be completed by next February. He would consent to an extension for a month or two with the condition that for every week afterwards the company should be under the strictest monetary penalties.

Mr. TRELOAR asked why Sir Joseph Savory, who was the chairman of the pioneer company which first took over the contracts, was not present that day to explain their action in the matter.

Eventually, after a long discussion, it was resolved, on the motion of Mr. WALLACE, that the request of the company could not be entertained at the present time.

NEW APPLICATIONS FOR ELECTRIC LIGHTING, ELECTRIC RAILWAY AND TRAMWAY POWERS.

THE *London Gazette* announces that the following powers are to be applied for to Parliament, and the Board of Trade:—

BLACKPOOL.—Applications to the Board of Trade for powers authorising the construction of tramways in the County of Palatine, Lancaster; also to authorise the promoters and the Corporation of Blackpool, and the Blackpool Electric Tramway Company, Limited, to enter into certain contracts and arrangements for the use by the promoters, their agents, or any of their servants, of the tramways of the Corporation.

BRIGHTON.—Application to Board of Trade for a provisional order to authorise the Brighton and Hove Electric Light Company, Limited, to supply electricity for public and private purposes; also other powers connected therewith.

CENTRAL LONDON RAILWAY.—Application to Parliament for powers to extend underground railway authorised by the Central London Railway Act, 1891, to Liverpool Street, the motive power employed will be electricity; abandonment of portion of the authorised railway; agreements with certain railway companies and the Corporation of London and other authorities and companies; also other various powers.

FAREHAM.—Application to the Board of Trade for a provisional order to authorise the Fareham Electric Lighting Company, Limited, to supply electricity for public and private purposes within the district of the Fareham Urban Sanitary Authority.

LIVERPOOL OVERHEAD RAILWAY.—Application by the Liverpool Overhead Railway Company to Parliament for extension of time for construction of authorised railways and works; construction of new railways, &c., electricity, steam, or other motive power to be employed; authorising further capital and borrowing powers; also various other powers connected therewith.

LONDON (SOUTH).—Application to Board of Trade for power to the County of London Electric Lighting Company, Limited, to produce, store and supply electricity, electrical energy, and power within the County of London; also various other powers connected therewith.

Application to Board of Trade for a provisional order to authorise the Camberwell and Islington Electric Light and Power Supply, Limited, to supply electricity in the districts of Saint Olave, Saint Saviour, Saint George the Martyr, Southwark; Newington and Lambeth, in the County of London, both for private and public purposes; also other powers connected therewith.

LONDON (NORTH).—Application to Board of Trade by the County of London Electric Lighting Company, Limited, and the Brush Electrical Engineering Company Limited, for power to produce, store and supply electricity, electrical energy and power within the County of London; repeal of the Clerkenwell Electric Lighting Order, 1891; and of the St. Luke's, Middlesex, Electric Lighting Order, 1891; and the various other incidental powers.

Application to Board of Trade for a provisional order to authorise Messrs. Sharp and Kent to supply electricity, electrical energy, &c., for public and private purposes in the Parish of St. Mary, Islington.

Application to Board of Trade for a provisional order to the Camberwell and Islington Electric Light and Power Supply, Limited, authorising them to supply electricity for public and private purposes in the district of the Hackney Board of Works, and the Parish of St. Luke, Middlesex, and the Parish of Clerkenwell; also other incidental powers.

LONDON (WEST).—Application to Board of Trade for a provisional order to authorise the Putney and Hammersmith Electric Light and Power Supply, Limited, to supply electricity in the Parishes of Hammersmith, Fulham, Battersea, and the district of the Wandsworth District Board of Works, for public or private purposes.

MIDDLESBOROUGH.—Application to the Board of Trade for power to authorise the Middlesborough electricity and electrical energy and power within the Municipal Borough of Middlesborough; also other powers connected therewith.

OXFORD.—Application to the Board of Trade for a provisional order to transfer to the Oxford Electric Lighting Company, the powers of the Electric Installation and Maintenance [Company, Limited; also alteration or amendment of the provisions of such order; and other purposes.

WARD'S ELECTRICAL CAR COMPANY, LIMITED.—Application to Parliament for power to Ward Electrical Car Company, Limited, and Secretary of State, County Council, and other authorities to enter into agreements with respect to use of electrical vehicles on streets, &c.; also other incidental powers.

We also understand that powers are to be applied for, for Dublin, Govan, Kilkenny, Limerick, Maidstone, Waterford and Whitechapel.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers, November 26th, 1891.

CONTINUATION of the discussion on the "Description of the Standard Volt and Ampèremeter used at the Ferry Works, Thames Ditton," by Capt. H. R. SANKEY, Member, and F. V. ANDERSEN, Associate.

(*Authorised Abstract.*)

Capt. SANKEY further described the resistance, A, used as an intermediary between the standard ohm and the rheostat, B, and explained a diagram of it. He showed that there were two mercury contacts at the ends of each strip, and these were in parallel when the strips were in parallel. There were thus ten contacts in parallel at each end, and calling the resistance of each contact m, and that of each strip s, the resistance in parallel will be $\frac{s}{5} + \frac{2}{10} m$. When the strips are in series there are 5 mercury contacts in series, and the resistance is $5s + 5m$. The parallel is therefore $\frac{1}{25}$th of the series resistance, the mercury contacts being eliminated. Recent tests of the resistance, A, when in series, gave 0·72678, and $\frac{1}{25}$th of this was 0·0290712. Direct measurement of the parallel resistance gave in two instances 0·029082 and 0·029075. He had tested a Siemens electro-dynamometer by the apparatus, and found its constant to be 28·50. The instrument was then sent to the makers to be recalibrated, the new constant being 28·41. The original constant was 28·67, and hence his determination was equal to the mean of the two given by Messrs. Siemens Brothers. Two errors in Table I. of the paper were pointed out: in column 3, line 4, the number 0·417 should read 0·0104, and in column 4, line 3, the number 1·66 should be replaced by 1·57.

Prof. AYRTON exhibited several diagrams illustrating his previous remarks, and showed several of the latest types of D'Arsonval galvanometers. He expressed his high admiration of the most perfect arrangements provided by Messrs. Willans and Robinson for testing the efficiencies of their steam engines, and he hoped they would not misunderstand him when he made some suggestions as to how their electrical test apparatus might be modified with advantage. The improvement made in D'Arsonval galvanometers by using curved pole pieces and freely suspended coils he illustrated by the calibration curves of two instruments drawn to a very large scale. The deviation from proportionality in the case of the improved form was inappreciable, whilst that of the ordinary type was very pronounced. He also directed attention to the fact that it was not necessary to use a large square sheet of sectional paper for such calibrations, only a narrow diagonal strip cut from the roll at an angle of 45° being required. The arrangement of platinoid sheet and D'Arsonval galvanometer used as a standard ampèremeter at the Central Institution, and also the hexagonal multiple scale fitted up at the Acme works, were illustrated by diagrams, and the secular variation of sensibility of D'Arsonvals were shown by means of tables. Referring to recent forms of instruments, he showed two new D'Arsonvals, both provided with adjustable magnetic shunts. One of these had been made by Mr. Pitkin and the other by Messrs. Nalder Brothers & Co., the coil of the former instrument being wound with "manganim" wire and that of the latter with platinoid. Both instruments have curved poles and freely suspended coils. Carpentier's long range D'Arsonval, an instrument deflecting through 180°, was exhibited, together with a shunt, by means of which the sensibility could be greatly varied. Speaking of the shape which should be given to the coils of D'Arsonval galvanometers, he called attention to a note on the subject presented to the Physical Society in March, 1890, by Mr. T. Mather, and he exhibited an instrument embodying the improvements there suggested. This galvanometer had a long narrow coil and no iron core, and, for its winding, was the most sensitive D'Arsonval he (Prof. Ayrton) had yet tested. On the subject of platinoid sheet rheostats, he said that instead of using a large surface, 6 feet by 3 feet 2 inches, as Captain Sankey and Mr. Andersen did, it would be better to have two sheets, one for currents, say, from 5 to 110 ampères, and the other from 50 to 1,100. If the narrow coil low resistance instrument mentioned above be used, the former platinoid sheet would require to be about

5 inches square, and the latter 15 inches square; with these the same range of current could be measured as with Captain Sankey's large rheostat, and no temperature corrections whatever need be made to obtain an accuracy of one-fifth per cent. Further, the expenditure of power when measuring 1,100 ampères would only be 40 watts, whereas the strip described in the paper absorbed about 1,300 watts when measuring the same current. He was glad to see the close agreement in Captain Sankey's measurements of the rheostat, A, in parallel and series, and wished to know why it was considered necessary to measure it in series at all, seeing that it could be measured so accurately in parallel, the condition in which it was used. The mercury contacts, although nominally eliminated, were nevertheless a source of uncertainty, and where the value of a resistance was of such vital importance their use should be avoided. Some of his students had recently tested such contacts, and found them to vary greatly according to their condition; in one case the resistance fell from ·00266 to 0·00058 on being cleaned and re-amalgamated. For calibrating the ampèremeter, he recommended the use of a known current measured, say, by a Thomson balance, for in this way all troublesome and uncertain measurements of small resistances were avoided.

Mr. CROMPTON said he wished to call attention to a few points which appeared to have been misunderstood. In the first place, some persons said the paper under discussion was unworthy of the Institution; with this he entirely disagreed, and thought the idea arose from misconception. He himself considered the paper a capital one to commence the session with, and particularly interesting to rising electrical engineers. The details of practical testing apparatus were always valuable, and little dodges of great use to others always accompanied papers such as the one before them. Again, English electrical engineers had established what was known as the English system of arranging central stations, viz., the combination of high-speed engines with direct-driven dynamos. Efficiency tests of this system showed that it gave better results than any other system. The Institution of Civil Engineers had acknowledged the completeness and accuracy of the "engine efficiency" tests of Messrs. Willans and Robinson, and he (Mr. Crompton) thought the electrical tests made as described in the paper were quite accurate enough for present requirements. Speaking as one who had paid considerable attention to accurate electrical measurement, he doubted whether resistances could be measured to 1 part in 10,000, as stated in the draft order in Council prepared by the Board of Trade. He had made many tests, and taken the greatest pains to obtain accuracy, but he found that it was not possible to get resistance boxes sufficiently well adjusted. Surface leakage difficulties were also very great, particularly in a London atmosphere. In their measurements at Chelmsford they preferred the zero method, and used D'Arsonval galvanometers, Clark's cells and potentiometers. The chief reason for the preference was that it was so easy to repeat a measurement, and errors were so readily detected. He enquired why Prof. Ayrton had not used electro-magnets instead of permanent ones in D'Arsonval galvanometers in some such way as Mr. Kapp and himself had done in ammeters and voltmeters some years ago. At present he was engaged on an electro-magnet instrument which he hoped would be a great improvement on any yet made.

Mr. SWINBURNE described the system of measurement explained in the paper as a calibrating system. In most station work it was usual to employ ampèremeters and voltmeters, and he thought this would continue. Such instruments were, however, of two classes, the accuracies of which were very different. It would not be satisfactory to use a voltmeter intended for house work, and costing 3 or 4 guineas, in a station where an accuracy of a fraction of a per cent. was required. A letter balance was a very good thing for its purpose, but it would be totally unfit for chemical weighings. Captain Sankey and Mr. Andersen had, he understood, put up the arrangement described, because they could not put confidence in other people's calibrations; neither could he himself; but a good instrument calibrated by the user would, he believed, be more satisfactory than the arrangement now before the meeting. He objected to "spot watching" in central stations, and thought the D'Arsonval galvanometer would not stay. A voltmeter might be accurately calibrated just as well as a D'Arsonval galvanometer. Most of the tests depended on standard cells, and considerable difference of opinion existed with regard to their reliability. If made in the same way from the same materials good agreement could be obtained between different cells, but this did not say they were right. Other persons were sceptical about the reliability of double-wound series resistances, and to examine this point his assistant, Mr. Bourne, made a coil of two insulated wires wound side by side. The insulation resistance was found to be over 600 megohms, and the insulation did not break down until the pressure between them amounted to 950 volts. This, he considered, proved that they were quite reliable. On the subject of platinoid he enquired whether its properties were permanent, and said that he could find no tungsten in it, and thought it was merely German silver with a large proportion of nickel. Speaking of resistance measurements, he said that for small values the fall of potential method was the most suitable, and by it a single bar of an armature could be easily tested. With reference to the use of electro-magnets mentioned by Mr. Crompton, he said that Mr. Boys had tried them, and found little or no advantage. Thomson galvanometers were much more sensitive than D'Arsonvals, and the only drawback was their being affected by external fields; but even this was not very important in null methods. In conclusion, he rather objected to a statement by Prof. Ayrton about the arrangement described by the authors being accurate enough for workshop purposes, and he pointed out that the most accurate measurements made, those of weight and length, were made in workshops; the former in commercial analyses, and the other by Whitworth measuring machines.

Mr. S. EVERSHED was surprised that more attention had not been paid to inaccuracies inherent in the instruments, for in addition to the variation of resistance with temperature, springs, torsion wires, magnets, &c., had temperature coefficients which ought to be investigated. Good magnets with fairly closed circuits were very permanent when left untouched, and he had used a tangent galvanometer with permanent magnet control for several years as a standard ampèremeter, and the change had been very small. The magnets of one D'Arsonval galvanometer he tested had a temperature coefficient of about 0·01 per cent. This was considerably lower than those usually found for magnets used in magnetic observations (0·02 to 0·03 per cent.), but several samples of Jowitt's steel tested by Mr. Vignoles gave about 0·01 per cent. per degree C. He therefore thought the ordinary coefficient was between 0·01 per cent. and 0·02 per cent. Speaking of the position of the point of attachment of the potential wires on the platinoid strips, he said they should be placed at some distance from the ends, so that the flow of current in the strip may be properly distributed. The new alloy "manganin" was, he believed, first tested in England by himself. Its temperature coefficient when received from the maker was very small, and was negative; but on having a wire drawn down to a smaller size its coefficient became positive. On enquiry, he learned that to prevent this occurring a special method of drawing had to be adopted. Another specimen had a temperature coefficient about − 0·01 per cent. per degree C. between 0° and about 160° C., but on keeping it heated to 160° its resistance fell considerably, and its specific resistance was permanently altered; its temperature coefficient was, however, about the same. From this he concluded that if permanency was required it should never be heated above 100° C. There was one form of D'Arsonval galvanometer which, although it had not been referred to, was worthy of attention, viz., the Weston voltmeter. He had recently tested one, and found it remarkably good and very accurate.

Mr. A. P. TROTTER wished to compliment the authors on the successful system they had carried out. He said it should be borne in mind that there were three classes of measurement carried out, respectively, in laboratories, workshops, and instrument-making factories. When the Society of Telegraph Engineers was first founded, resistances were measured in miles of telegraph wires, and electromotive forces in Daniell's cells; subsequently, when the name was changed to Society of Telegraph Engineers and Electricians, laboratory methods were employed, but now it was necessary to measure as electrical engineers. He considered the method adopted at Messrs. Willans and Robinson's a laboratory one, and thought the D'Arsonval galvanometer had not come to stay for workshop uses, for "spot watching" was not acceptable to engineers. Quartz fibres had also revolutionised Thomson instruments, and they were highly sensitive and reliable. At present, he did not see that workshop electrical measurements need be made to an accuracy of less than one in a thousand.

Mr. WILLANS said the need for such an arrangement as that fitted up by Captain Sankey and Mr. Andersen arose from the fact that dynamo makers had confidence in no measuring instruments except their own. They (Messrs. Willans and Robinson) formerly used Siemens instruments, but the zero adjustment was troublesome, and only one person at a time could take the readings. With a spot of light two or more may take the readings, and this gave confidence to the parties interested. The average value of the quantities were those required, and Captain Sankey's method of taking the mean deflection and then calibrating it, was, he thought, preferable to Mr. Crompton's zero method or that of Prof. Ayrton, who relied on the spot always being in a definite place. The general result of the more accurate testing arrangements was to slightly lower the efficiencies. This, he said, was what might have been expected, for with imperfect instruments one was likely to take the highest of the several values obtained. Their experience was that most commercial instruments were unreliable when used in workshops near masses of iron, &c., hence the D'Arsonval form was adopted.

Captain SANKEY, in reply to Prof. Ayrton, said that the latter depended upon the accuracy of his scale, whilst they did not; hence the devices for obtaining proportionality were, in their case, unnecessary. By using a larger rheostat they were able to employ a galvanometer of fairly high resistance with sufficient accuracy, and then their ampèremeter galvanometer and their voltmeter galvanometer were interchangeable. The method of calibrating by using a known current was hardly possible in a workshop, for the copper deposit method was not convenient, and if another standard instrument be employed, they would be depending on other people's calibrations. To avoid this, the method of checking and standardising described in the paper was devised. To Mr. Evershed he pointed out that as the value of the mean deflection was determined immediately after every important test, the additional corrections he had referred to were eliminated. In designing the rheostats, they had taken care to put their potential wires at points where the flow was uniform.

Mr. ANDERSEN said that in calibrating the mean deflection, only the standard ohm and the standard cell were relied on. Ohms could be made so as to be very near the Board of Trade requirement of one part in 10,000. As regards cells, Mr. Swinburne seemed to be under too much apprehension about them. He himself knew from experience that they could be made up to agree very closely with the standard value, when once one had got the "knack" of doing it. He was glad to know that "spot watching" had a good chance of being largely used by engineers, for a good spot was far superior to any pointer. Referring to the design of D'Arsonval galvanometer, he said some of the points mentioned by Prof. Ayrton were good, but he did not agree with the system of winding them with platinoid. An instrument so wound was necessarily about 25 times less sensitive than one wound with copper. Curved pole pieces and freely-suspended coils were good; the latter he himself had used several years ago. Magnetic shunts he thought unsuitable for workshop use. A resistance box was better, for one could trust a person to use the proper plugs. The six scales on the roller he considered unnecessary, for only one scale was required, and five other sets of figures.

The CHAIRMAN (M. A. Siemens) agreed with Mr. Trotter as to the great advance made in electrical measurement since the formation of

the society. The paper now before the Institution was a proof that electrical engineering had now become a science, and he doubted whether any other profession could show such a record of progress made in so short a time.

NEW PATENTS—1891.

19,824. "Electrical spiral lamp for general lighting purposes for railway carriages, tramcars, and cabs." W. G. POTTER and C. MIDGELEY. Dated November 16th.

19,835. "Improvements in gravity control, as applied to electric measuring instruments." W. A. CROOK and H. J. PAYNE. Dated November 16th.

19,854. "Improvements in dynamo brushes." J. DICKSON and R. G. SHAPCOTT. Dated November 16th.

19,865. "Improved method of applying magnetised plates, wire, or the like, to boots and shoes." J. PAGESMITH and F. WARREN Dated November 17th.

19,895. "Improvements in incandescent electrical lamps." J. ATKINSON. Dated November 17th.

19,899. "Improvements in telephone closets, and other structures, where it is desirable that they should be practically sound proof." T. WEIGHILL. Dated November 17th.

19,900. "Improvements in or relating to welding or working metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated November 17th. (*Complete.*)

19,901. "Improvements in or relating to welding or working metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated November 17th.

19,909. "Improvements in telephonic transmitters." A. MARR. Dated November 17th.

19,914. "Improvements in or connected with electric arc lamps." J. B. BARTON. (Communicated by W. Jandus, United States.) Dated November 17th.

19,919. "An electric lamp for lighting and signalling at sea and land and for deep sea fishing." W. G. POTTER and C. MIDGELEY. Dated November 17th.

19,926. "An electric cable seating for laying in the cable for house-to-house supply for laying in the wires." W. G. POTTER and C. MIDGELEY. Dated November 17th.

19,952. "Improvements in magnetic separators." W. D. HOFFMAN. Dated November 17th.

19,965. "Improvements in and relating to conduits for electric conductors." J. C. LOVE. Dated November 17th. (*Complete.*)

19,968. "Improvements in electric motors and dynamos." M. C. BURT. Dated November 17th. (*Complete.*)

19,971. "Improvements in or connected with electrical measuring and indicating apparatus." E. L. MAYER. Dated November 17th.

19,972. "A new or improved device for varying the resistance in telephone circuits." E. L. MAYER. Dated November 17th.

19,975. "Improvements in and relating to electric arc lamps or lighting apparatus." F. V. MAQUAIRE. Dated November 17th.

19,996. "Improvements in electric alarum clocks." J. NICHOLLS. Dated November 18th.

20,026. "Improvements in multiple switchboards for telephone exchanges." G. A. NUSSBAUM. (Communicated by L. Mandronx, France.) Dated November 18th.

20,033. "Improvements in dynamo-electric machines." S. D. WILLIAMS. Dated November 18th.

20,059. "An electric gondola." J. HUTCHINSON. Dated November 18th.

20,063. "Improvements in the use of transformers." J. A. FLEMING and R. T. D. BROUGHAM. Dated November 18th.

20,078. "An improved automatic and electric check till." R. GAY and W. H. JACKSON. Dated November 19th.

20,109. "Improvements in electric switches." W. H. STURGE. Dated November 19th.

20,111. "Improvements in methods of electrical distribution." J. H. RIDER. Dated November 19th.

20,126. "A magnetic carrier or plugger for dental purposes." H. C. BRAUN. Dated November 19th.

20,139. "Improvements in electric signals or indicators." J. T. GENT, A. W. STAVELEY, and I. H. PARSONS. Dated December 19th.

20,144. "A new or improved system of communicating visible signals and establishing electrical and telephonic connection between central town and district stations, and mechanism and appliances connected therewith." C. EGGAR. Dated November 19th.

20,215. "Improvements relating to electrical machines and to reversing and interrupting apparatus for use in connection therewith." C. B. HARNESS. Dated November 20th. (*Complete.*)

20,217. "Improvements in dynamo machines." J. S. FAIRFAX. Dated November 20th.

20,226. "Improvements in arc electric lamps." T. B. GRANT. Dated November 21st.

20,230. "Improvements in electric arc lamps." J. H. RIDER. Dated November 21st.

20,234. "A method of and apparatus for telephonic transmission." E. L. MAYER. Dated November 21st.

20,247. "Improvements in solenoids, particularly applicable to automatic sound signalling apparatus, but which may also be used for other electrical purposes." J. S. YULE and C. K. MARR. Dated November 21st.

20,257. "An improved electric arc lamp." (Communicated by La Compagnie de l'Industrie Electrique, Successor and Representative of La Société d'Appareillage Electrique, Switzerland.) W. P. THOMPSON. Dated November 21st. (*Complete.*)

20,271. "A new or improved electric teething neckband for infants." J. C. MORTON. Dated November 21st.

20,279. "Improvements in electric cables." G. G. M. HARDINGHAM. (Communicated by the firm of Felter and Guilleaume, Germany.) Dated November 21st.

CORRESPONDENCE.

Electrical Measuring Instruments.

At the Institution of Electrical Engineers, last Thursday night, I stated my regret that some of our technical journals should have under-valued Captain Sankey's paper which we were then discussing. In stating these remarks I had in view your leading article on the subject. As that article has been widely read, and my remarks may be only read by a few, I shall be glad if you will allow me to point out that you were in error in supposing that Captain Sankey's description of the electrical measuring instruments employed at Messrs. Willans's works was not of great interest to the profession in general. My reasons for thinking so are the following:—

We English engineers have carried out our large plants of electric generating machinery in a style which has become the English style of central station; that is to say, we employ high speed steam dynamos consisting of dynamos made by various makers driven in most cases by Willans engines. This combination of machinery has given exceedingly high economical results, far exceeding those that have been recorded either on the Continent of Europe or in America. From 83 up to 87 per cent. of the horse-power indicated in the steam engine cylinders has been delivered in the form of electrical horse-power at the terminals of the dynamo, and hence the steam used per E.H.P. has been reduced to an extremely low figure. It is well known that Messrs. Willans possess appliances of approved accuracy for measuring the I.H.P. and recording the steam consumption of their engines. It was not equally well known that their electric measuring instruments were thought out and worked to the same degree of accuracy. Captain Sankey's paper puts this on record for the first time. He states the special precautions which have been adopted to ensure great accuracy of measurements, but what he omitted to say, and what came out at the discussion, was that the results of the electrical measurements had been many times checked by independent and competent electrical engineers, and that the results had been in every case verified to the degree of accuracy claimed in the paper. Further than this, the paper was one well suited for discussion by the audience which attended the meeting. The audience was largely composed of young electrical engineers, who are every day handling instruments of this class, and who are consequently exceptionally well fitted to discuss the means employed or to suggest improved ones. It may be quite true that to those conversant with cable testing or with the working of some few of our London testing establishments the details furnished by Captain Sankey may not be novel, but I am convinced that to the majority of electrical engineers the instruments employed and many of the details of the arrangments were novel, and would form a welcome addition to their stock of knowledge on this subject.

R. E. Crompton.

Deviation of Compass.

Can anyone say what was the magnetic declination in the neighbourhood of Calcutta 30 years ago, and what it is now?

Ajax.

November 28th, 1891.